THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

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CONTENTS

"PRODUCTION FOR PLENTY" by Sir Cecil Weir, K.C.M.G., K.B.E., M.C., D.L. 297

PRINCIPAL OFFICERS 1953/4 302

THE PRACTICAL ENGINEERING APPROACH TO THE INTERCHANGEABILITY OF MANUFACTURED COMPONENTS, by Professor Dr. Ing Otto Kienzle . 303

THE CORTINA-ULISSE PRIZE, 1953 311

THE ENGINEER'S PART IN THE PRODUCTION OF POTTERY, by J. Robinson, B.Sc., A.M.I.Mech.E., A.C.G.I. 312

AUTOMATIC LOOMS AND THEIR APPLICATION, by F. C. Sheldon . . . 326

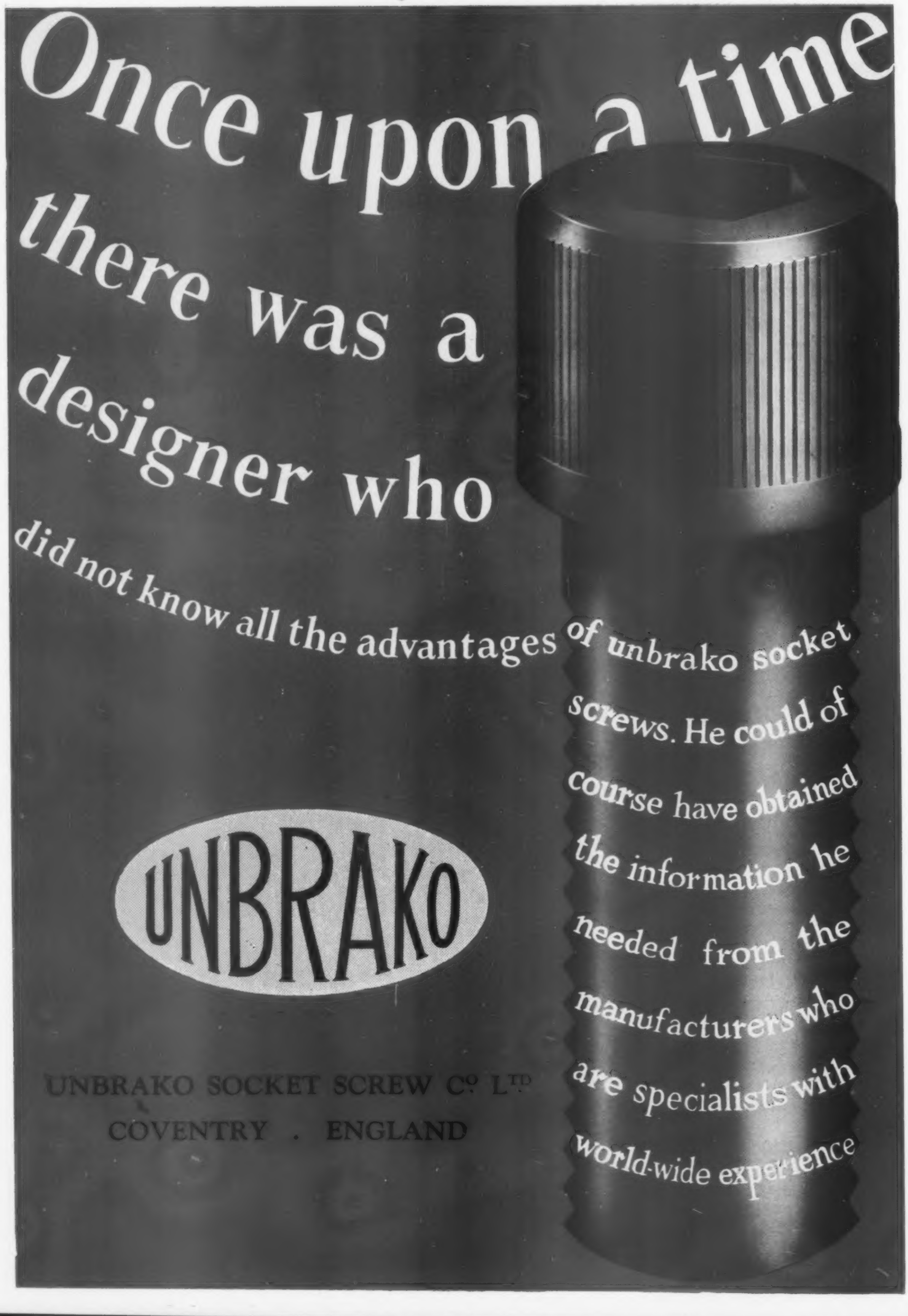
PRODUCTIVITY MEASUREMENT IN SWEDEN 327

INSTITUTION NOTES 328

NEWS OF MEMBERS 328

NEW APPOINTMENTS 329

HAZLETON MEMORIAL LIBRARY 331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"Production for Plenty"

by SIR CECIL WEIR, K.C.M.G., K.B.E., M.C., D.L.
President of the Institution, 1952/53.

In place of the usual leading article, the Institution publishes the President's address to the Harrogate Conference, delivered on 26th June, 1953.

THIS Conference will be my last appearance as President of the Institution. I feel particularly pleased and honoured that it should be in the year of the Coronation of our young and gracious Queen, Elizabeth the Second, and that the subject of this Conference, "Production for Plenty", should be such a stimulating and inspiring one.

This title is very well suited to Coronation Year. The first Elizabethan period was an era of adventure, initiative, enterprise and activity in every sphere of our national life. In culture, in literature and the arts, in exploration and discovery, in pioneering and in the development of the crafts, it surpassed any previous period in our history. We continue today to draw inspiration from the story of that reign. We have seen great times since, years of endurance, years of achievement, years of victory, years of tremendous industrial progress when the whole character of our economy and the condition of our people have been changed and transformed and we are ready to go forward to a still more glorious future. The first stage of this new beginning—for every step forward is a new beginning—should be accomplished in this second Elizabethan reign and it can well be termed "Production for Plenty".

Need for A New Outlook

We need, in my opinion, once again *a new outlook*. The programmes and policies which emerged in other times sprang from the conditions existing in those times. There were hard and difficult conditions for many, perhaps for most people in a large part of the Victorian era. The rapid advance of industry, the increase in population, the sprawling growth of towns and cities, the development of transport and machinery, created problems of urgency and complexity. One hundred and fifty years ago it took a British statesman, called to power in England while he was travelling in Europe, as long to travel from Rome to London as it took a Roman Emperor to travel from London to Rome some seventeen hundred years earlier. Today it takes just four hours.

But with the development of industry and population came a growing consciousness of the importance of the individual, a realisation of the rights of man to share in the fruits of work and invention, a recognition that social welfare and education were not, and could no longer be, the privilege of the few and that standards of life and of living must be built up so that all would be cared for and those who were willing to make genuine efforts should be denied no opportunity of advancement in the sphere in which they had chosen to work.

There followed from this a century of what can well be called progress in its most fruitful period in the early part of the present century. A period unsurpassed, even today, in the variety and character of the reforms to which it gave birth in political, social and industrial legislation; the extension of the franchise, the widening and freeing of education, the liberalisation of trade, the development of health services, insurance against unemployment, the fuller recognition of trade unions and joint consultation between employers and employees. Interrupted though the social advances were by two World Wars, which incidentally gave striking evidence of the solidarity of the British people in times of crisis, progress

continued and today there is a higher sense of citizenship in many quarters and a nearer approach to equality of opportunity than ever before.

The point of this narrative is not to boast about or preen ourselves on what has been accomplished in this free and liberal-minded land. It is to demonstrate that a great change has occurred and that now, after the Second World War, we require *a new outlook* which takes account of a fresh situation and provides a new stage from which to launch out into new adventures in the domain of human progress.

A Combined Operation

In the Institution of Production Engineers we do not make political speeches, that is to say, not from any party angle. In a democratic country everything is in effect political, it springs from governmental action initiated and approved by the free votes of a free people. It is right that one should say that the progress I have described has not been due to the efforts or the genius of any one political party. It has, in fact, been a combined operation in which the clash and conflict of argument and debate, conducted as we know so well how in this essentially parliamentarian nation, have played a notable and wholly constructive part.

Of course, each political party will lay claim to authorship of this terrific social advance—that is fair political tactics and we can leave them, each of us in our capacity as a citizen participating in the argument, to fight it out amongst themselves. The main thing that concerns us here *is that it has happened;* the Britain of today is very different from the Britain of bygone days. Only the spirit and the soul of the people remain as they have been throughout our long and inspiring history. The lesson I derive from this is that men and women should recognise *the new facts* and proceed from them to fresh endeavours. It is futile and indeed harmful to argue as though there were today in the minds of enlightened industrialists any thought of oppression or suppression of their workers. Indeed, in these days their minds are set, partly it may be for material reasons, but largely, I believe, because of the changed outlook to which I have referred, on improving conditions of work, on facilitating production, on finding new markets abroad and larger markets at home, on providing pension, welfare and recreational arrangements which will, even in the largest of public companies, enable a family spirit to take root and develop. I do not suggest that there will not continue to be differences of opinion with regard to hours of work, wage rates and many other matters affecting operatives in factories. Therefore the need for trade unions, for joint consultative bodies and sometimes even for drastic action on one side or the other, will go on. But by and large the development of output, the increase of productivity, are not obstructed by the fears and apprehensions and injustices of other days and can be approached and resolved by common action and agreed measures on the part of management and operatives alike.

Let us make no mistake about this compelling fact—that Britain *dare not* be complacent about her trade. The free world may be, indeed there is every indication that it is, more co-operative than it has ever been. But a corollary of freedom is competition and if we are to remain free and not go over to *dirigiste,* syndicalised, wholly planned economies which would stultify enterprise and to a large extent frustrate, discourage and, certainly, inhibit initiative, then competition will be sustained and even fierce. To meet this competition and even to maintain our present position amongst the industrial and trading peoples of the world we shall have to be efficient, effective and flexible to a still greater degree than we are at the present time. To deal with the situation so that we shall not only hold our place in competitive conditions, but also widen the areas of consumption for the benefit of all—our competitors as well as ourselves—we shall have to participate in *new schemes* for the creation of fresh and expanding markets, for the development of new resources of food and raw materials, for the raising of the standards of other people so that civilisation may progress and our own standards not be pulled down.

Significant Developments in Europe

I have said that we are confronted with a *new world.* We are also confronted with a *new Europe.* Already there is a functioning supra-national body in the European Coal and Steel Community to which

six nations, Germany, France, Italy, Holland, Belgium and Luxembourg, have transferred their sovereignty and responsibilities in respect of the two two most vital products of industry, coal and steel. These industries have ceased to be controlled by the six national governments concerned. They now come under the governmental supervision and direction—in so far as direction is required—of the High Authority of the European Coal and Steel Community, a supra-national government in this sphere representing 158 million producers and consumers.

If, after the ratification of the Treaty for a European Defence Community, giving the same six nations a single army, navy and air force, the third stage of a political community should be accomplished, with the development of a common economy and a common market for the same vast population, and such other free nations as may decide to join the integration movement, *we shall have something to reckon with which should not be under estimated,* an area in which tariffs and discriminations will progressively be abolished and in which national planning will become supra-national planning.

Of course, the United Kingdom will be associated in some appropriate way with these Communities when they become established—I am myself the Head of the United Kingdom Delegation to the High Authority of the European Coal and Steel Community, and we have just given wide and far-reaching guarantees of association to the European Defence Community—but we have never agreed to transfer our sovereignty to the supra-national bodies.

I mention these significant European developments, the building up of which we have officially encouraged and approved, to underline my contention that the world of today and the days to come will not be the same as the world of yesterday.

For these reasons if for no other—and there are many others, too many to enumerate—we cannot rest on our past economic and industrial achievements, we dare not indulge in unrealistic expectations of ease and self-satisfaction; we shall have to fight hard, work hard, programme and plan with intelligence and flexibility, so that we may march forward with, and in the van of, an army of industrialists and traders whose task is to raise the standards of their own peoples and to extend the conditions, ideals and amenities of a free civilisation to all mankind.

I make no apology for purple passages of rhetorical analogy at this early hour in the morning. If we are seeking material benefits for our fellow citizens at home, and for our brothers and sisters beyond the seas, we must be actuated and activated by more than material gain if we are to succeed. Man must have a mission as well as an individual incentive and while we may be shy about expressing these things, they must be recognised if they are to generate the energy, understanding, endurance and determination that are essential to success.

"Production for Plenty": that is the theme of our Conference and first of all "*productivity*". "*Plenty*" will flow from "*productivity*"—*never* the other way round. To achieve productivity is the task *par excellence* of the Production Engineer, but every operative, every element in management, must be his ally and partner. The Production Engineer, working in collaboration with the mechanical engineer, the electrical engineer, the chemical engineer, the civil engineer, the cost and works accountant, and all other trained and expert associates can evolve new systems of production techniques, adapt old techniques to new machines, simplify operations, improve the flow of processes, reduce the strain on labour, diminish, and perhaps abolish, that most frustrating of all deterrents of effort—monotony, raise manshift output, increasing earnings while reducing costs,—but he cannot do it without the conscious and sustained support both of the operative and his trade union.

From the standpoint of a Production Engineer this is a man-size job and a challenge to applied knowledge and human understanding. The success of his efforts, considered in the aggregate, will be to enable British products to be made at prices and in quality and quantities that good and enterprising salesmanship will be able to market freely at home and for export.

Importance of Salesmanship

I mention *salesmanship* because it is no less important a factor in trade than manufacture. But no

salesman, however skilful, can make or hold a market if he is at a disadvantage with his competitor in price or in quality. With all the advantages at his hand he will still require to possess energy, knowledge and initiative, if he is to find enough customers for the goods he sets out to sell.

I mention *export* because it is the key to our prosperity. At all costs we shall have to hold and wherever possible expand our overseas trade. No other country is so dependent on export as we are. Already 20 per cent. of our gross national product is being sold abroad and even so we are not yet able to balance our payments nor to permit imports to be free of control or our currency to be convertible. We must either produce more at home of the things we need, or we must earn more of other currencies by increasing our exports. I would like to see us do both. At the risk of repeating my famous story, which some of you may already know, I will tell you about the friend of my younger days who, on leaving the parental roof to start in business on his own account, received a letter from his sound but somewhat conventional father advising him " to remember to spend less than you earn ", to which my friend replied : " I shall not take your advice this time, Father. I intend to earn more than I spend ". Like my friend I, too, am an expansionist and I think that his reply should be adopted as our motto for trade.

Percentages do not always convey the message that one wants to deliver. When I tell you that our gross national product is of a value of about twelve thousand million pounds and our exports are running at about two thousand five hundred million pounds, you will appreciate the immensity of the task, more especially when you realise that many of the articles in the gross national product are not exportable, and that the percentage of exports in some of the other items is as much as 70 or 80 per cent.

If " productivity " is the means of retaining our existing markets by giving us low-cost production from well paid operatives and if, in due course, it will provide " plenty " for an everwidening number of consumers, we would do well to examine the problem of achieving high productivity and the chances of finding fresh markets in which to dispose of its yield.

Obstacles which can be overcome

On the first of these points, the short answer is that there is no insuperable obstacle to the achievement of high productivity. I mean by this no practical obstacle other than the finance that is required for the modernisation and re-equipment of factories and plants. That is a problem for the Chancellor of the Exchequer—so to plan the incidence of essential taxation that we shall not be prevented from equipping industry with the latest and most efficient machines. If this were not to happen, we would be left behind in the race for trade and the last stage of the national revenue would be much worse than the first!

But there are psychological obstacles to bigger manshift output which must be overcome by the joint efforts of management and trade union leaders, who understand as well as employers—as reports of the Anglo-American Council on Productivity have shown—the urgent need for lower-cost production. There is the recollection of mass unemployment, of the miseries and degradations of dole drawing, of slumps in demand and the short time that results from these. There is the fear that bigger manshift output will call for fewer operatives and lower piecework rates. There is too little appreciation of the established fact that new and more efficient machines, while sometimes calling for less workers in the factories using them, sometimes call for more workers to deal with increased demands for their product and in any event, do not need to lead to less employment in the aggregate. The new machines also need to be made, and modernisation should be a continuing process.

Nevertheless, these psychological obstacles exist and could positively prevent the re-equipment and equipment that are required. They will only be removed by frank and open discussion as between all elements in industry, and by a growing recognition of the fact that the very dangers that are feared will most certainly happen in another way if we should fail to keep abreast—and indeed slightly ahead—of technical and plant developments and improved processes. In these discussions the Production Engineer is well qualified to take a prominent and constructive part.

Creation of Common Markets

If all these difficulties, financial and psychological, should be overcome, there still remains the question of markets. When you have plenty of goods you want plenty of customers, plenty of consumers, plenty of markets. This is where we need first of all a radical revision of our ideas. Such a revision is taking place in Europe by the creation of common markets where the movement of goods and of men is not impeded by currency regulations, customs duties, quotas and transport and other discriminations. The achievement of "*plenty*" will call for still wider trading areas, for longer term credit arrangements and for financial mechanisms of an intra-governmental character designed to assist the expansion of business.

We have gone some way in that direction. Under the auspices of the Organisation for European Economic Co-operation, first the Intra-European Payments Agreement and then the European Payments Union loosened the shackles of bilateral trade, and American Marshall Plan Aid operated to prevent balances of payments from getting too far out of equilibrium. But these expedients and palliatives *are not cures* and the continuance of American Aid in its present form is too uncertain and conditional. When we were a creditor country, we realised that we could only make markets by investing in them and that even though later we lost some of our investments, the trade resulting from the credits which they created recouped us time and time again. It was a good economic philosophy, suited to the times in which it was applied. But *new times* not only require *new men*, they also need *new measures*.

The Marshall Plan has given us an idea and on some such lines, adapted to a different proportion of problem, and on the basis of long-term credits, primarily for capital goods and equipment but not necessarily so restricted, we could set the backward and undeveloped areas to work, create opportunities for labour, prizes for enterprise, developing resources for food and raw materials, building up vast numbers of consumers with advancing standards of living and transforming the hearts and minds of men and women everywhere by directing their energies and efforts into channels of fruitful and peaceful progress. This I firmly believe is not only practical policy, it is the only practical means of linking "*productivity*" with "*plenty*", when we have come to see that to live unto ourselves alone is not only bad doctrine but an objective which, in the short term, let alone in the long term, would be suicidal and self-destructive.

These great schemes, requiring for their fulfilment huge financial operations and permanent organisational machinery, are for governments to work out and for intra-governmental arrangements to organise. The essential thing is that so far as manufacturers and traders are concerned, they should not be plagued and confused with problems of currency transfers, but only with the standing in their own currency and country of the customers to whom they sell. It is through his government, who is his trustee, and through the agreements between his government and other governments participating in this world development project, that the individual citizen's part will be engaged.

I have deliberately refrained in this opening session from encroaching on the subjects with which the distinguished speakers at the other plenary sessions will deal in their addresses. I have not attempted either to touch on technical matters which are the subject of some of our discussion groups at this Conference, at our Summer School and in the Papers delivered throughout the year in London and at meetings of Sections. Even if I were able to contribute usefully to these questions—which I know that I am not—this would not be the occasion for me to do so. But I shall advance my education by attending some of the meetings of the discussion groups.

My aim has been to *introduce* the subject of our Conference, to show, I hope, that a high rate of productivity is a necessary as well as a worthy objective to work for; that it is achievable in this country as well as in the United States of America; that quality, particularly in the case of this country, with its need for a high and sustained level of exports of manufactured goods and products, is the most vital ingredient to retain in the increased production we achieve, and that it is in the interest—indeed it is in the imperative interest—of management and workers, of consumers and citizens, that we should not fail.

I have nailed my flag also to the mast-head of "*plenty*"—"plenty" not for those only who live in this sound and steady and progressive land, but for the teeming millions of men and women of every race and colour and religion who have—potentially we may be sure—the same needs as we have, and who are entitled to earn the same rights and to share the same aspirations.

PRINCIPAL OFFICERS 1953/4

THE PRESIDENT

Mr. Walter C. Puckey, M.I.Prod.E., F.I.I.A.

Members of the Institution will have learned with great pleasure of Mr. Puckey's election to the Presidency for 1953/54. His sterling work for the Institution over many years, and in particular as Chairman of Council during 1950/52, has made a major contribution to its growth and development, and some of the most progressive steps have been taken under his leadership.

Mr. Walter C. Puckey

Mr. Puckey's career, not only in the engineering world but in public affairs, has been marked with distinction, and his recent term of office with the Ministry of Supply, as Deputy Controller of Supplies (Aircraft Production), gave him an opportunity to devote his exceptional ability and energy to the successful fulfilment of one of the most important appointments in the country at the time.

Prior to joining the Ministry of Supply, Mr. Puckey was Director and General Works Manager of Hoover Ltd., and during the war had many close contacts with Government Departments. After the war he served as an independent member of the Hosiery Working Party appointed by Sir Stafford Cripps, and later became a member of the Dollar Exports Board, under the Chairmanship of the immediate Past President, Sir Cecil Weir, K.C.M.G., K.B.E.

Mr. Puckey is also a Director of The British Tabulating Machine Co. Ltd.

In spite of his many activities, Mr. Puckey finds time to travel widely and has become known to members of the Institution through his many personal visits to Local Sections. He has recently visited Australia as the Head of a Government Mission and he took the opportunity, whilst there, to address the Institution Sections at Adelaide, Melbourne and Sydney. Mr. Puckey was deeply impressed by the warmth of the welcome extended to him by Institution members in Australia.

Under his stimulating and farseeing guidance, the Institution confidently looks forward to continued progress and even greater expansion.

THE CHAIRMAN OF COUNCIL

Mr. Harold Burke, M.I.Mech.E., M.I.Prod.E., M.I.I.A., Joint Managing Director of Concentric Manufacturing Co. Ltd., Birmingham, has been re-elected Chairman of Council for 1953/54.

Mr. Burke is also on the Boards of the Subsidiary Companies, Metaducts Ltd., Brentford; Rowmill Metals, Ltd., and T. Miller, Ltd., Birmingham.

THE VICE-CHAIRMAN OF COUNCIL

Mr. G. Ronald Pryor, M.I.Prod.E., Managing Director of Edward Pryor & Son, Ltd., Sheffield, has been re-elected Vice-Chairman of Council for 1953/54.

COUNCIL ELECTIONS 1953/54

As a result of the Ballot, the following members have been elected to serve on Council for the year 1953/54:

Members: Mr. H. W. Bowen, O.B.E.
Mr. R. M. Buckle
Mr. W. Core
Prof. T. U. Matthew
Mr. A. L. Stuchbery

Associate Member: Mr. R. S. Clark

The next Council Meeting will be held at 36, Portman Square, London, W.1, on Thursday, 23rd July, 1953.

LOYAL MESSAGE TO THE QUEEN

An illuminated address, conveying the Institution's loyal greetings, has been sent to the Home Secretary for presentation to Her Majesty the Queen, and acknowledged on behalf of Her Majesty by Sir David Maxwell Fyfe.

THE PRACTICAL ENGINEERING APPROACH TO THE INTERCHANGEABILITY OF MANUFACTURED COMPONENTS

by Professor Dr. Ing. OTTO KIENZLE

Presented to the Birmingham Section of the Institution, 24th June, 1952

Professor Kienzle is the Professor of Machine Tools and Head of the Institute of Machine Tools at the Technological University of Hanover. During the past 25 years, he has been a leading international authority on standardisation and on systems of limits and fits.

Until 1939, he was Chairman of the I.S.A. Committee which developed the system of tolerances used with great advantage and economy on the Continent.

At the time of his lecture, Professor Kienzle was visiting the Department of Engineering Production at the University of Birmingham under the Rockefeller interchange scheme.

Professor Kienzle (right) with Professor T. U. Matthew, Head of the department of Engineering Production, University of Birmingham, who presided over the meeting.

MY subject is one which has for thirty years been prominent in the German Institution of Production Engineers. This Institution has been established as a specialised organisation within the framework of the Verein Deutscher Ingenieure—abbreviated V.D.I.—which is the Association of German Mechanical Engineers. It has helped the advancement of interchangeable production by arranging lectures in most industrial centres. The development of practical measurement and the training of engineers in its technique caused the V.D.I., in 1938, to organise another specialist organisation to deal with measurement in production. This organisation formed several centres for the measurement of gear wheels, surface roughness, hardness and so on. In education at technical colleges, as well as at the technological universities, much attention is paid to the principles of interchangeability, which are of basic importance for economic production.

If we look at modern industry we see costly machines, more or less automatic, working with accurate tools of special materials which lead us to higher productivity. At the same time the manufacture of engineering components has touched a level of precision, which seems easily to fulfil all requirements. But precision costs money and, from an economic point of view, we have to ensure that only economic accuracy will be applied.

Why high precision? Did machines not run thirty years ago? They did, but more slowly, sometimes with noise and often with a short life and a low degree of efficiency. These qualities can be improved only by higher precision.

There is still another requirement, interchangeability. That means manufacture of matching components independently from each other in place and time in single production as well as in batch or mass production. In principle, interchangeability is a condition of standardisation, indeed, it is its realisation; for standardised parts are often manufactured by specialist firms which ship them for assembly in other factories.

When talking about interchangeability, we think firstly of dimensions and their tolerances and it is certainly not a simple task to ensure that all kinds of dimensions are within given limits. Such dimensions include diameters, lengths, distances, threads, gearwheels and forms for cams, turbine blades, etc.

Dimensional Tolerances

Dimensional tolerances may be subdivided into four groups—size; form or shape (e.g. straightness, roundness, location); distances between centres or concentricity of diameters; and surface roughness.

This latter was apparently invented to add to the troubles of Works Managers. But all this does not

fulfil the condition of full interchangeability. Much more is required, namely, that one component can be interchanged with any other with reference to any physical property that may be of importance. Such properties may refer either to basic material, or to components modified during production by hot or cold working, or heat treatment. Later, we have to consider weight, elasticity and, in some cases, electrical, magnetic or optical requirements. Colour and appearance are often important, for example, on the fender of a motor car. Such components coming from the machine shop should be assembled without selection and without adjustment; in this sense full interchangeability is an indispensable condition of flow production in assembly.

Increasing productivity involves mass production; this is not only a matter of demand, but also of general industrial organisation. Simplification, comprising reduction of the innumerable, unnecessary variety of sizes and shapes, is particularly necessary.

In mass production, operating times are reduced to the minimum level by modern machinery; but in assembling, the best method of reducing times is to use full interchangeability.

Thus the target is defined. But, as we approach it, we find that the fair way is unfortunately littered with bunkers. In the following part of this Paper, I shall confine myself to dimensions of metal components and I shall try to throw a spotlight on design, scheduling, tools, jigs and fixtures, machine tools and measuring.

The Design Office

First we come to the Design Office. It is here that active measures for interchangeability have to be initiated. Before a tolerance is indicated on the drawing, the draughtsman should observe the following rules :

(a) Avoid tolerances on shape as far as possible; the natural accuracy of the shape may often satisfy requirements.
(b) If definite limits are to be set, choose tolerances as large as the function will allow.
(c) Limits should be set so that, if exceeded, the piece is not only declared scrap but is, in fact, unusable.
(d) Tolerances must have due regard to the manufacturing process.

It is a very important principle to set limits which on one hand, ensure function and, on the other, economy. An experienced draughtsman should therefore be responsible for fixing tolerances and, when in doubt, should seek the advice of the Tool Office as early as possible.

In this work, the draughtsman can avail himself of several standards for cylindrical limits and fits, for threads and so on. You may be interested to hear something of the use of the I.S.A. system in Germany, a system which has recently been circulated in the form of a draft specification by the B.S.I., with a view to its eventual adoption in this country.[1]

The I.S.A. System is rather similar to the systems formerly used in Germany, Sweden and Switzerland. It has, however, the advantage of having more comprehensive ranges of tolerance—grades or qualities and also of fits. The fundamental features are :

(a) *A series of* 16 *tolerance qualities*, geometrically stepped, of which eight are provided for machined components. Each tolerance quality means a *series of tolerances* for a range of sizes from 1/16″ up to 20″ and is symbolised by a *number*.
(b) Unilateral systems on both hole and shaft basis.
(c) A series of allowances for both clearance and interference fits, symbolised by small letters for shafts and by capitals for holes.
(d) A free choice of combinations, on one hand between allowances and tolerances and, on the other, between zones of shaft-tolerances and zones of hole-tolerances.

From all these possible combinations only a limited number is generally recommended. A particular branch of industry, say the machine tool builders, selects certain fits, the particular firm or department making a still more restricted selection according to its special requirements. For example, a firm may have selected two qualities for holes, obtaining different combinations with two running fits, one transition fit for the inside diameters of ball bearings, one light press fit and one shrink fit.

Here we see the combined symbols of letter for the allowance and number for the quality. A total symbol for a particular fit reads as H7–$\overline{\text{Fp}}$ or H7/⌈p6.

Special Aspects

Without going into more detail, I would like to draw your attention to two special aspects :

(a) As every symbol comprises the tolerance number, it is easily seen which machining operation may be used when scheduling. As the range of tolerance is rather wide, it is clearly indicated that large tolerances are available and should be used as often as possible. This wide range of tolerances is likely to promote economic production. This was one of the reasons why the I.S.A. System was welcomed in practice and why it was introduced into German industry within a few years.

(b) The other feature refers to the interference fits specified, which are much more numerous than in any other system. A large number of interference fits is necessary because the particular press fit or shrink fit required is obtained by calculation of the stresses in the mating parts and resistance of the assembly to axial forces or torque.

Considerable research work on these fits has been carried out in my Institute and is still going on. Two important results of this are :—

(i) In elastic materials, the theoretical limit of elasticity on the inside diameter of a

[1] Draft B.S. 164 Part 1, 1951.

collar may be exceeded without damage. Large tolerances are therefore often available and were added to the I.S.A. System in Germany. An example shown in Fig. 1 is taken from a small mechanism, where a rather complicated assembly comprising a wheel, a collar, rivets, a pin and a stepped shaft is replaced by a plain press-fit-assembly. Although the assembly on the left seems stronger, the resistance to torque provided by the one on the right is still larger than the torque transmitted by the gear. Many other simplifications are to be found in machine design, for example, in assembled crankshafts for motors in ships.

(ii) The resistance can be influenced by the widely varying nature of the mating surfaces with coefficients of friction ranging from 0.05 to 0.5, or even more.

From a former investigation we know that in shrink fits where an outer component of steel is heated in air to more than 300°C., the oxydised surface increases the friction coefficient to 0.2. In a more recent study the fact was revealed that, if both mating steel parts are oxydised, the coefficient of friction rises to 0.4 or 0.5.

This is nearly the same value as that which is reached by using a suggestion of the late Prof. Meyer of Delft, Holland. He introduced silicon-carbide grains between both parts. We developed the appropriate manufacturing device, which comprises a rotating table for the shaft and two spray-guns, one of which sprays lacquer on the shaft, whilst the other sprays on grains of about 250 mesh size (Fig. 2).

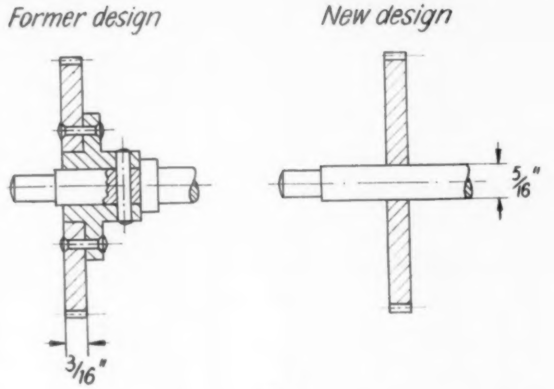

Fig. 1
Press fits for gear wheels in a small mechanism; material saved, 65%; time saved, 70%.

The effect is that particles of grit grip and at the same time increase the stresses, because they keep the mating parts a definite distance apart.

So much for cylindrical fits. The *thread tolerance system* need only be mentioned since the British Standards are well known and have served as a model for standards in other countries.

It may be of some interest, however, to have a

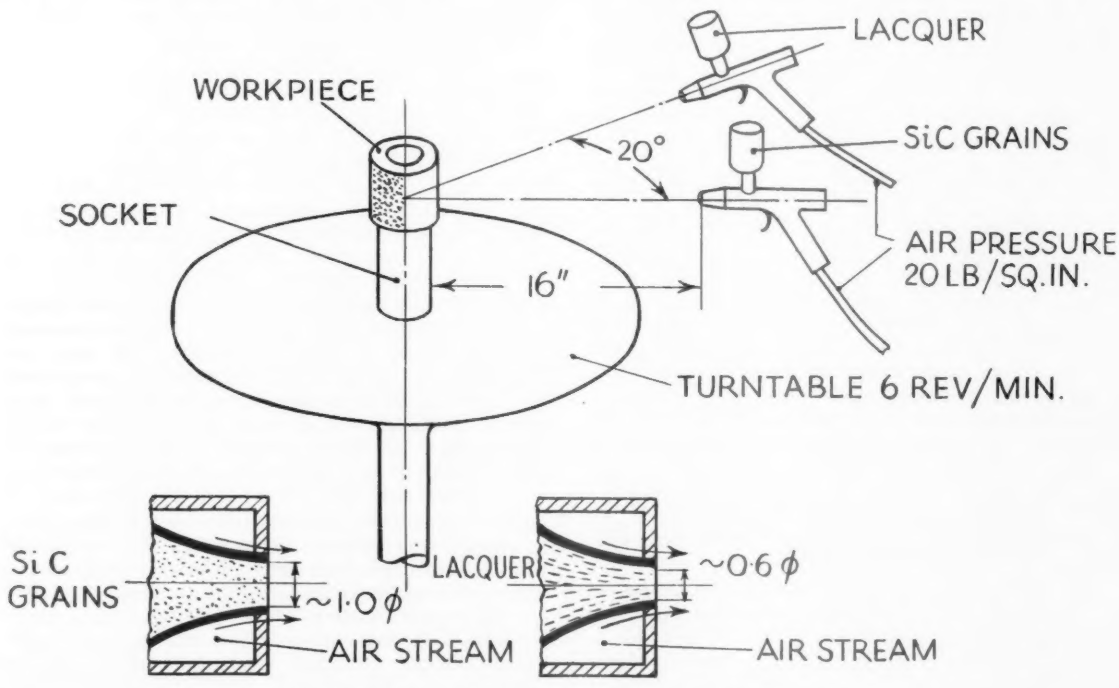

Fig. 2 Device for spraying lacquer and grains on the surface of the inner part of a shrink fit.

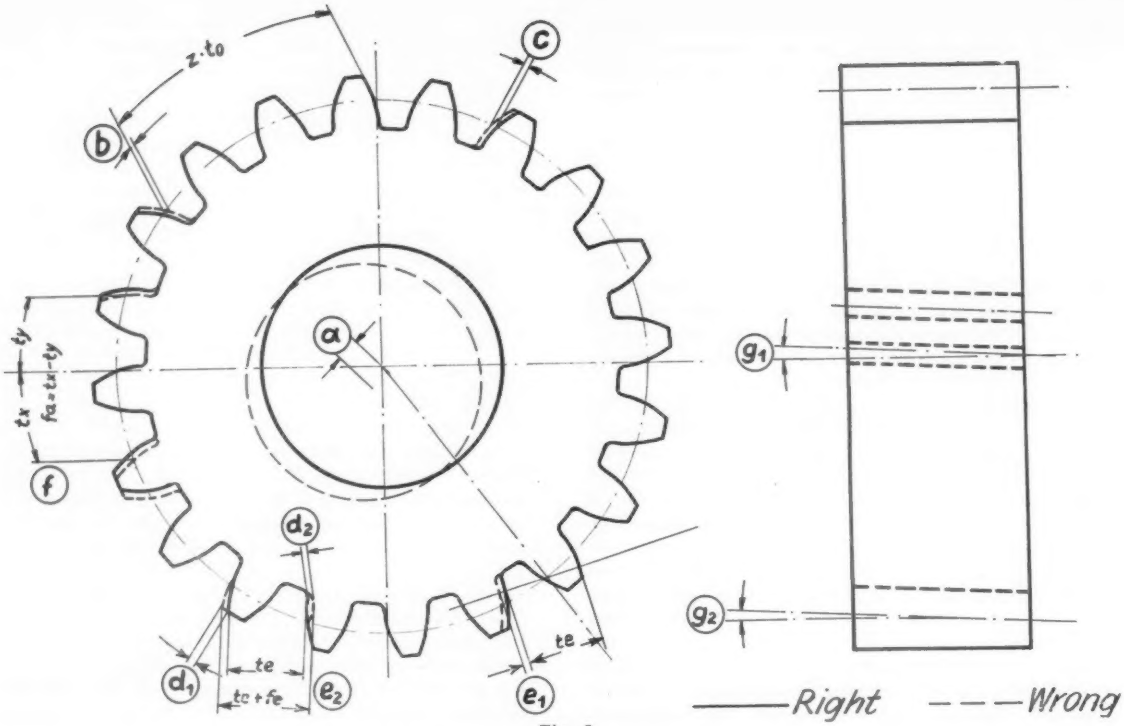

Fig. 3
Gearing tolerances—seven types of errors, (a) to (g).

look at a recent standard developed in Germany for gear wheels (Fig. 3). After thorough research in my Institute on economic tolerances in manufacturing, I had the opportunity to present a draft standard, which was partly founded on the wide experience obtained with the I.S.A. System. The abstract of this system comprises the following features:

(a) A definite series of types of error, namely:—
  (i) eccentricity (a)
  (ii) cumulative circular pitch error (b)
  (iii) tooth thickness error (c)
  (iv) error in form of involute (d^1, d^2)
  (v) base circle pitch error (e^1, e^2)
  (vi) pitch difference between one pitch and the next (f). (It is not permissible for one to be a maximum, while the next pitch is a minimum.)
  (vii) deviation from true parallelism in spur gears or from the true helix angle in helical gears (g^1, g^2).

(b) For each error in a certain range of pitches and diameters, tolerances are given in geometrically stepped qualities.

(c) For a particular gear wheel, various tolerances may be taken from different qualities in order to facilitate production. Take, for example, a gear wheel, running *slowly* in one direction, but heavily loaded; it requires small tolerances for base circle pitch and for alignment, in order to avoid high local pressure; but large tolerances on tooth thickness are permissible.

(d) For application in the well-known use of gear testers, a cumulative tolerance is provided. Here we bear in mind that an instrument in which the meshing gears are pressed together by a spring-loaded slide does not at all conform to the ordinary behaviour of gears, running on fixed centres and always having a clearance on one flank. We have, therefore, provided another cumulative tolerance for one flank gearing and, for this, measuring devices were developed. Although I shall deal with the measuring devices later on, let me now discuss the instrument of the Physikalische-Technische-Reichsanstalt, which corresponds roughly to the N.P.L. The two gears are held at a fixed distance by two discs accurately corresponding to the pitch circle diameters. The small disc is fixed to the base; the pinion is fixed to the shaft and the shaft is free to rotate in the base. The large disc is coupled with the large gear and has a planetary motion around the pinion. Now, if there is any error in pitch between the two gears, we shall notice relative motion of the pinion and shaft, within the base, and this motion is recorded.

I have devoted a considerable section of my Paper to this chapter on design and basic standards because you cannot have economic interchangeability if you do not have a drawing correctly dimensioned with tolerances.

Scheduling

The next step is *scheduling*. Under the aspect of interchangeability, the particular operation depends not only on shape and dimension, but also on accuracy. The production schedule should take into account the individual tolerances from the very beginning of operations and should be built up with the object of approaching the final accuracy step by step, but with as few steps as possible. Often the mistake is made that roughing operations should go on right up to the final operation, which is expected to produce the full precision all at once. Take, for example, a drop forged shaft which has to be turned. As the depth of cut alters, reacting forces cause a slight displacement of the tool, so that the turned shaft is still out of round. If a shaft with such an error is ground immediately afterwards, a residual error still remains. This demands, on one hand, reasonable tolerances for raw materials such as bars, drop forgings and castings and, on the other hand, rigid machines and a well graded series of operations.

A striking example is given in the reaming of holes (Fig. 4). If the diameters of the drilled holes vary within a large tolerance, the result of reaming is only a certain reduction, say from quality " 11 " to quality " 9 ". If accuracy within a small tolerance is to be reached, the variation of the hole must be reduced by an intermediate operation, so that we start by reaming from a hole in the ninth quality in order to attain a quality as fine as the sixth. IT2 is the tolerance of the diameter of the reamer itself.

Another way of reducing the number of operations is illustrated by coining the bosses of drop forgings, so that only one grinding operation is necessary.

The reamer leads us to the *tools*, which have to be held within definite limits, if the accuracy of the piece depends on them. The reamer itself has, therefore, to be ground within a tolerance of quality equal to that of a plug gauge.

You see from this example the convenience of talking in I.S.A. Qualities (symbolised by the letters IT, meaning International Tolerance).

Again, I should like to emphasise that it will not be satisfactory merely to get within the limits, if a *more economic* sequence of operations is possible. Let us consider the very exact hole. By a thorough investigation of the proper increments in a broaching tool we succeeded, on a mass production basis, to finish the drilled hole of 1" dia. and 2" length immediately after drilling. Fig. 5 shows the distribution of allowances within .01" for the drilled hole and within ½" x .001" for the broached hole.

A moot point is the milling cutter, for on its true running the surface roughness depends. Many a grinding operation could be saved if all teeth of milling cutters were exactly the same distance from the axis of rotation (Fig. 6). But that is impossible, as long as we use mandrels with clearances and keyways.

This draws our attention to the fixing and mounting of tools and components. In this country, as well as in Germany, progress has been made by using elastic

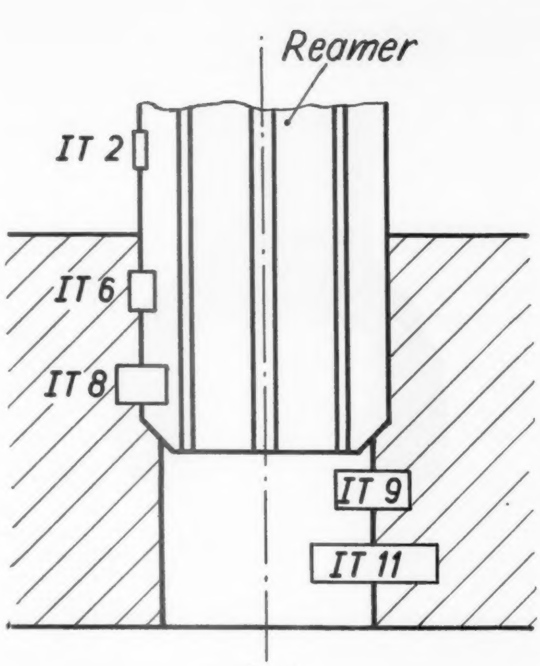

Fig. 4
Tolerances for drilled holes (right) and reamed holes (left).

expanding mandrels without saw cuts. Here is a fully detailed example (Fig. 7) ; 6,000 brass bushings had to be diamond turned concentric with their bores at a speed of 1,400 feet per minute. The mandrel has a carrier which is placed between rubber pieces on the face plate, and contains a rubber sleeve which can be expanded by a screw acting upon the taper.

For changing the component a device is fastened on the lathe; the assembly is put into the slot, the taper is released with a key, the piece is withdrawn downward and another piece is put on and clamped by the expansion of the mandrel. This expansion is restricted by two rings, one of which is clamped whilst the other still remains loose. I have gone into detail on this particular device, which is the product of a work study, in order to stress the principles of a satisfactory operation.

At the other end of the infinite variety of jigs, I would refer to one used for the very first operation on a casting. The casting is put into a transparent jig of Plexiglass, aligned according to its contours and clamped. Two holes are then drilled and these serve as locations in the following operations. In this way, the rather large variations of a casting may be overcome with the consequent reduction of scrapped work.

I am sure I need offer no further examples, for every Production Engineer knows that interchangeability of components depends to a high degree on the correct location of the work piece, the accurate position of drill bushings, and so on.

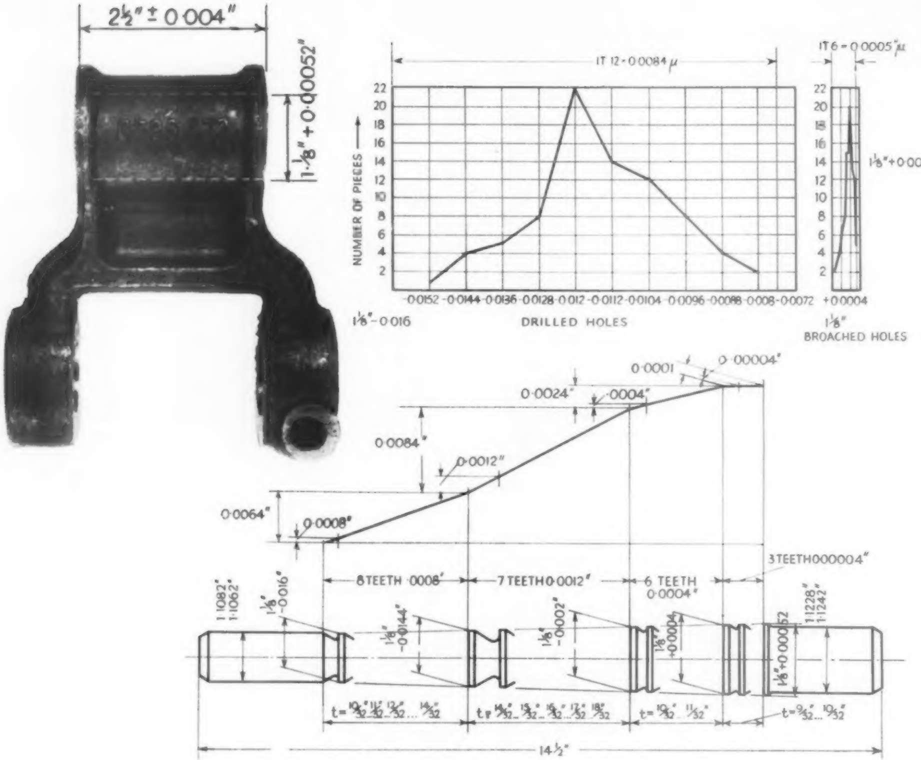

Fig. 5
Tolerances for drilled and broached holes.

Machines

When we look into the catalogues of machine tools, we find that most of them are called precision machines. We have to introduce a definite correlation between the accuracy of the machine and the permissible errors of the component. Sometimes the precision of a particular feature may be unnecessarily high, sometimes it will not be quite sufficient; it is surely going too far to insist on the utmost precision of every particular machine which you buy. Two examples will illustrate this:

(a) The pitch error of a thread is influenced by the sum of a number of errors of the machine, such as the error of the lead screw, and errors in the transmission gears. Errors also arise from slight axial movements of the lead screw and of the main spindle, due to faulty alignment of the thrust faces. Any errors in straightness of the guide ways cause the tool to make additional movements in the direction of its traverse. When fixing the limits for all these errors on the machine, we start from the permissible tolerances of the components to be machined, and analyse them thoroughly in this way.

I developed this idea into what you might call a diagram of errors as shown for a radial drilling machine in Fig. 8. We ask "Which error in the work piece is attributable to an error in the machine ?"

The following errors are to be found in the machine :—

1. Imperfect flatness of the base plate.
2a. Internal taper of the spindle is not exactly round.
2b. Its axis does not coincide with the axis of rotation.
3. The axis of the spindle is not perpendicular to the plane of the base plate.
4. The motion of the spindle sleeve is not perpendicular to the base plate.
5. The column is not perpendicular to the base plate.
6. The guide way of the radial arm is not parallel to the base plate.
7. The elastic deflection of the column and radial arm is excessive.

Perhaps we could find further imperfections, but these seem to have the greatest influence on the machined component. Errors 2 and 4 result in oval

or too large holes; 1, 3, 5 and 7 result in malalignment of the axes of holes. Error 6 influences the accuracy of faces of bosses but, if these are not to be faced, no attention need be paid to the tolerance for error 6.

I consider that Production Engineers should bear these factors well in mind, not only for acceptance of new machines, but for two other reasons.

To ensure interchangeability at all times, machines which show serious wear have to be inspected and rebuilt to the standard required by the tolerance of the components to be produced. For instance, why worry about a worn lead screw on a lathe if, in future, the lathe will be used only for plain work ?

The other use of such a table of errors is that it can help, when ordering, towards an agreement between customer and producer, in any particular case.

Measuring Instruments and Gauges

We have to look upon measuring problems from two points of view. All the accuracy demanded in tools, fixtures and machines necessitates inspection methods of sufficient accuracy. This gives rise to many measuring methods and instruments, quite apart from those used for the inspection of components.

Indeed, the whole range of this apparatus forms the backbone of a shop's ability to engage upon interchangeable production. The precision of tools and fixtures can be ascertained by measuring their dimensions; but in the case of a machine tool that alone would not do. As it is not sufficient to check the components of a pudding, but as we prove the pudding by eating it, so a machine tool should also be checked by the production of at least one definite sample piece. But in the case of machines for mass production, it is my opinion that Production Engineers will be more interested in the accuracy arising from repetitive work.

One should measure a certain number of components and make a chart of the distribution of errors. The curve obtained is rather irregular, but is inherent in the process which shows the percentage of pieces falling into the various group intervals. It may be replaced by a Gaussian curve, which has the advantage of enabling us to utilise its mathematical properties and apply standard deviations. So we use statistics to calculate the probable percentage of rejects.

Now a statement about the working precision of the machine can only be made in relation to the percentage of rejects.

"If you find within a tolerance of say .0018" 5% rejects, you will have within a tolerance of 0.0022" only 0.5% rejects."

For the inspection of the components before they go to assembly, I have seen in this country so many outstanding instruments that I should like to restrict myself to a few points which we have found important in our work in Germany.

The 'Go' and 'Not-Go' gauge is a rather simple and reliable means of inspection in the hands of an unskilled man. But many gauges do not follow a principle, which was revealed by a British inventor, W. Taylor, (not to be confused with Frederick W. Taylor of the United States) in an old British Patent No. 6200. We call it for short the Taylorian principle and it can be summarised briefly as follows :—

> "The 'Go' side of the gauge should touch as much of the whole surface of the component as possible, but the 'Not-Go' side should touch only a very small portion of the surface." (Fig. 9.)

An example in general use in this country, following Taylor's invention, is the plug gauge for screw threads, which has a full thread on the 'Go' side and only one or two threads with truncated flanks on the 'Not Go' side. It is therefore surprising that, for straight holes, the Taylorian principle is infrequently used in this country, as it should be to comply with the I.S.O. recommendations. That is to say, a plug gauge should be used on the 'Go'

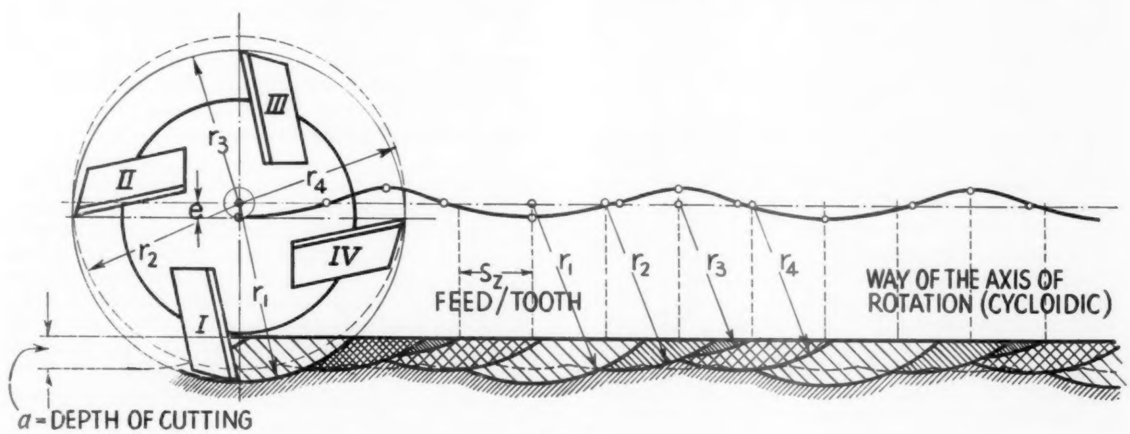

Fig. 6
Eccentricity in milling cutters.

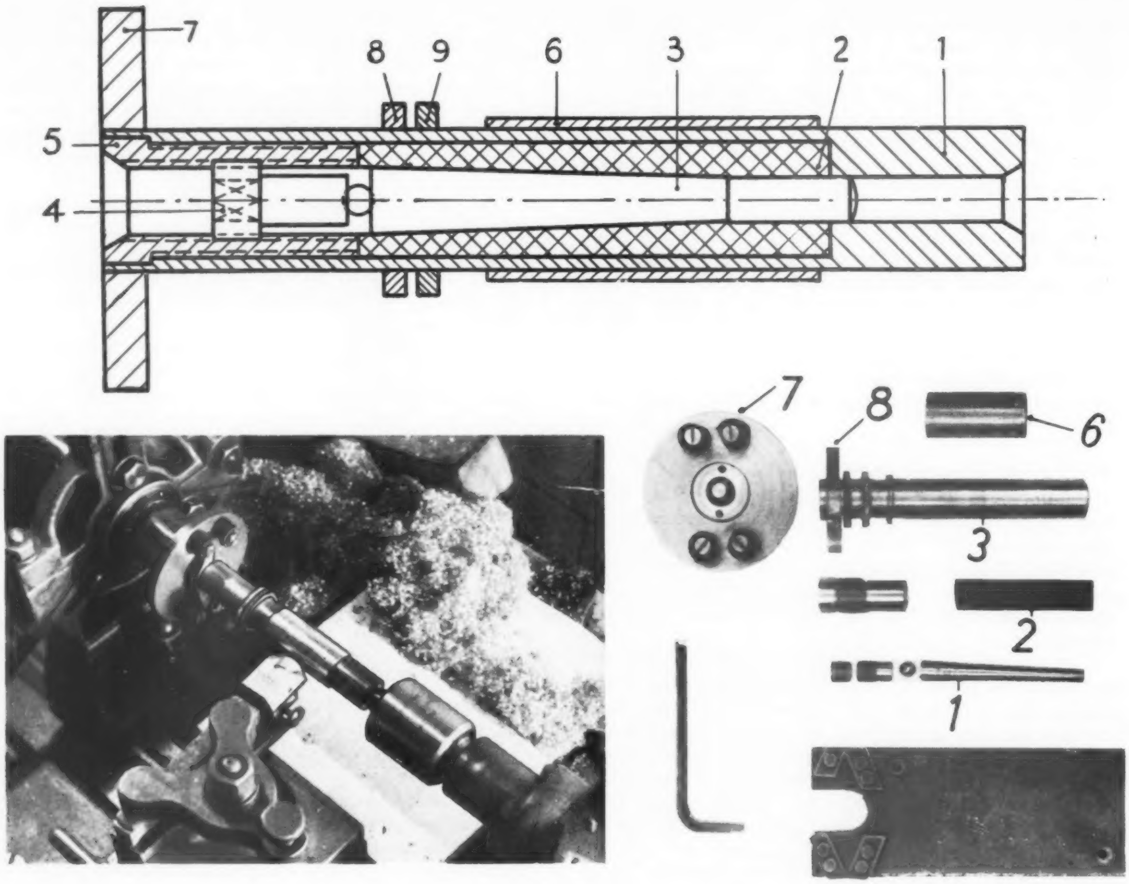

Fig. 7
Expansion mandrel without saw cut for precision turning: V=1,400 feet/cu. in.; N=100 rev/sec. 1) Mandrel; 2) Rubber; 3) Taper pin; 4) Square hole of screw; 5) Nutto (4); 6) Workpiece; 7) Face Plate; 8) Carrier; 9) Control Ring, fast after clamping.

Side and a spherical end gauge on the 'Not-Go' side. This principle is indispensable for the detection of oval holes, for example in the housings of ball bearings and for press fit assemblies. There is a corresponding gauge for square holes. Shafts are generally not submitted to this principle, because we may rely on sufficient accuracy of roundness being produced quite naturally by the machine. It is, however, applied sometimes to thin shafts for use in small mechanisms.

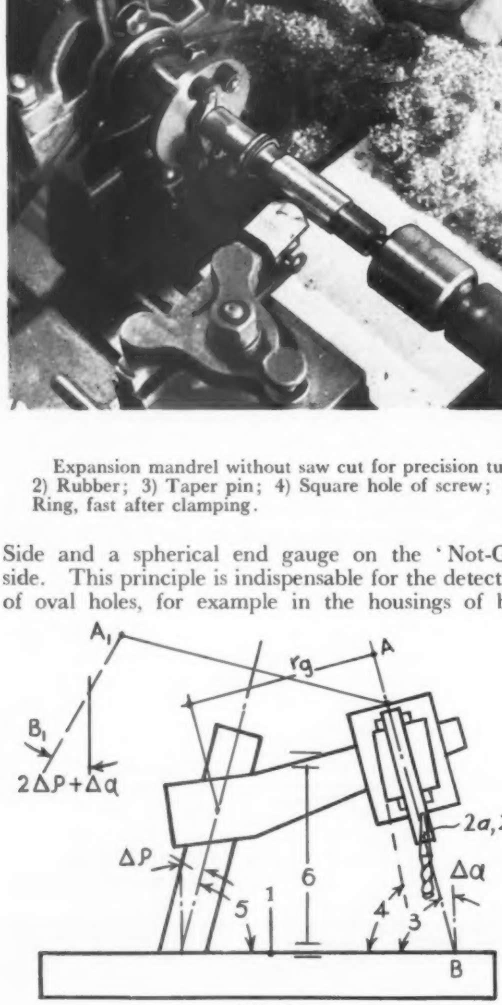

Fig. 8
Errors on a radial drilling machine causing errors on drilled components.

Inspection of Large Quantities

The next point I want to stress concerns the inspection of large quantities. The usual gauges may be modified to accelerate the measuring operation in several ways. Firstly, the gauge may be designed so that it can be handled easily and quickly, e.g. the so-called pilot gauge, which has a guiding cylinder in front of the gauge cylinder or the spherically ended gauge used on a large diameter on the 'Go' side, which will enter the bore easily and can be moved in it.

Secondly, a series of gauges may be arranged on a board so that, following a motion study, movements are as simple as possible when inserting the component into the successive gauges.

Thirdly, multiple gauges may be used, in which several dimensions are checked at one time by indicator gauges or electrical contacts. Such designs will help greatly to reduce the costs of inspection. Fully automatic inspection should be used only in large quantity production of components not heavier than about 2 lb.

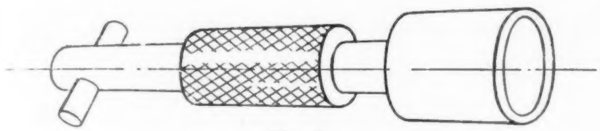

Fig. 9
Elastic expanding mandrel without saw cut.

Solid gauges meet increasingly strong competition in the use of indicator gauges for several reasons: the latter apply a definite measuring force, suffer minimum wear and, furthermore, you can see where you are between the limits.

Conclusion

Now I come to the conclusion. I have no doubt that most of what I have spoken about was already known to you as Production Engineers. My purpose was to tell you how we in Germany look on the *total concept* of interchangeability.

I shall now try to sum up the main points of my Paper. What in my opinion seems to be necessary is:

1. To design for simplified interchangeability, and to specify proper tolerances on the drawings.
2. To link tolerances with the manufacturing process and with the time and costs of production.
3. To maintain equipment such as tools, fixtures, machines and gauges within proper limits.

All this may be summarised in a concluding sentence: "He who governs the tolerances, governs economic production."

THE CORTINA-ULISSE PRIZE, 1953

The "Premio Europeo Cortina-Ulisse", awarded annually for a scientific publication, is promoted by the cultural international magazine "Ulisse", in the belief that culture must be a common instrument of civilisation and not the privilege of a few.

The prize of one million Lire (approximately £600), was awarded in 1949 to a work on chemistry by the British author, John Read, entitled "A Direct Entry to Organic Chemistry"; in 1950 the prize was assigned *ex aequo* to "L'idea dell'Unita Politica d'Europa nel XIX e XX secolo" by Carlo Morandi and to "La Guerre de Secession" by Pierre Belperron; in 1951 to "Come si comprende la pittura" by Lionello Venturi; and in 1952 to "Dynamic Aspects of Biochemistry" by Ernest Baldwin.

This year the Prize is being organised in co-operation with the Italian National Productivity Centre, and will be awarded for a work concerning economical and social sciences, specifically dealing with Productivity.

Only works printed for the first time in Europe during the last five years will be taken into consideration. In order to allow participation of works at present being printed, the expiring date of the five years will be 31st October, 1953.

The works must be submitted either by the author or by the publisher to The Editor, RIVISTA ULISSE (Sezione Premio Europeo Cortina-Ulisse), 43 Corso d'Italia, Rome, Italy, before midnight, 31st October, 1953.

Monographs, acts, memoirs, academic reports and publications for schools cannot be considered.

The works must be sent in to the above address in triplicate. Those written in a language other than Italian, French, German or English must be accompanied by a printed or typewritten translation into one of these languages.

The prize of one million Lire will be presented to the winner at Cortina d'Ampezzo, Italy, on Sunday, 20th December, 1953.

If the winning publication is not by an Italian author, and it is not yet translated into Italian, the Jury will recommend its translation and publication to an Italian Publishing Company.

The Committee of Honour of the European Prize Cortina-Ulisse is composed of the Minister of Public Education (President); the President of the Accademia Nazionale dei Lincei, Prof. Vincenzo Arangio Ruiz; the President of the Consiglio Nazionale delle Ricerche, Prof. Gustavo Colonnetti; the Vice-President of the Comitato Nazionale per la Produttivita, Ing. Guido Corbellini; the General Director of Libraries and Academies at the Ministry of Public Education, Dr. Guido Arcamone; the General Director of Cultural Relations with Foreign Countries at the same Ministry, Dr. Attilio Fraiese; the Director General of Cultural Relations with Foreign Countries at the Foreign Office, Dr. Bartolomeo Migone; the Rector of the Economics and Commerce University of Ca' Foscari, Venice, Prof. Gino Luzzatto.

The prizewinning work will be selected by a jury of nine members appointed by the Ministry of Public Education, the Accademia Nazionale dei Lincei, the Consiglio Nazionale delle Ricerche, the Comitato Nazionale per la Produttivita, the Italian Delegation of UNESCO, and the Editor of the magazine "Ulisse".

THE ENGINEER'S PART IN THE PRODUCTION OF POTTERY

by J. ROBINSON, B.Sc., A.M.I.Mech.E., A.C.G.I.

Presented to the Stoke-on-Trent Sub-Section of the Institution of Production Engineers, on the 13th October, 1952.

Mr. J. Robinson

Mr. Robinson has, for the past five years, been Chief Engineer to Josiah Wedgwood & Sons, whose "garden factory" at Barlaston continues the tradition founded by the original Josiah Wedgwood in 1759.

After completing his education at the Spenborough Technical College and the City & Guilds College (Imperial College), London, where he gained a 1st class Honours degree in Mechanical Engineering, and a Whitworth Prize, Mr. Robinson joined W. H. Allen, Sons & Co., of Bedford. He later became Chemical Plant Engineer with The British Celanese Company, and subsequently joined the Royal Naval Cordite Factory, Dorset, as Assistant Chief Mechanical Engineer.

Immediately prior to taking up his present appointment, Mr. Robinson was Chief Engineer to The British Drug Houses, London, and in this capacity established a new factory at Poole, Dorset, for the Laboratory Chemicals Group.

ENGINEERING has been defined as "The art of directing the great sources of power in Nature, for the use and convenience of Man". The branches of engineering separately recognised today, are illustrated by the titles of the various engineering institutions, there being the Mechanical, Civil, Electrical, Production, Structural, Heating and Ventilating, and Chemical Institutions, to mention only a few. These branches can all contribute some aid to the work of the potter, together with other "outsiders" such as the chemist, the physicist, the statistician, and the artist.

On the other hand, it must be realised that it is perfectly possible to make pottery without engineering aid of any sort. The clay can be washed, sieved, settled, dried out, wedged with mallets, pressed to shape, dried and fired, in very simple apparatus, all built by the potter himself.

It is proposed, in this brief review, only to mention in passing those services which engineers render to almost all modern, competitive industries, in common with pottery, and to concentrate attention on the more specialised services to that industry. Tableware pottery *only* is to be dealt with, leaving out of account such branches as tiles, figures, electrical porcelain, and chemical stoneware.

Briefly then, industry generally relies upon the engineer for steel-framed or reinforced-concrete buildings in which to work; electricity, produced by engineers, as motive power, and for lighting; heating and ventilating for comfort, and such useful services as compressed air, live steam, or vacuum. Mechanical transport, by truck, or overhead or belt conveyor, is another important asset in the modern factory.

The engineer's services to the problems of the present time can be grouped under six headings, namely:—

1. Mechanisation.
2. Furniture or Fixtures.
3. Rationalisation.
4. Protection.
5. Instrumentation.
6. Processes barely possible by hand.

A few examples (somewhat disconnected) will be given of what has been done in each group, rather than any attempt made to trace potting through its processes in sequence. In actual practice, this is the way engineering science is applied; first to one sub-process, then to another at a different part of the chain, and bit by bit the ancient craft becomes modern and efficient.

MECHANISATION

This takes the back-breaking hard work or, in the expressive potteries' term, the "mauling", out of the job which, incidentally, is usually done faster and better (except in the opinion of some old school die-hards), than is possible by hand. The figure of electrical energy used per employee is interesting. American industry, in general, uses 2.9 kW per person! British industry takes $1\frac{3}{4}$kW, and a modern British pottery about 0.4 kW. Even if all the firing is done by electricity, the figure only totals 1.4 kW. This shows the potential field for mechanisation, even though potting is classified as a "light" industry!

Blunger

One of the obviously laborious pottery operations is the breaking up of a raw clay, sometimes "rock-hard", into a homogeneous suspension in water, so that purification and blending can be carried out on readily handled liquids. This is accomplished by the "blunger", where rotating arms fling the lumps against flat sides, and perforated "dash-plates", so that reduction is accomplished in two or three hours.

Ball Mill

The very earliest potters discovered that clay alone could not produce a good pot. Today we add calcined flint, stone, and calcined bone (for china), with "frits" (really glasses) of borates, to give the glaze coatings. All these materials must be reduced to a fine powder, so as to be capable of remaining in water suspension, and thus become miscible with the clay suspensions. From the earliest times, the grinding process was too laborious for manual work, and was performed by grinding in "pans" driven by horses, wind mills, water wheels, etc.

Today, the Ball Mill is the standard machine. It has a beautiful simplicity, consisting simply of a rotating cylinder, wherein the continuous cascading of "balls", (or pebbles in the ceramic industry), reduces the material by continuous attrition. There are "wet" grinding, and "dry" grinding mills. It will readily be realised that small pebbles are required for fine grinding, and large pebbles for rough "crushing". A simple cylinder contains a heterogeneous mixture (Fig. 1).

The "Hardinge" Mill (Fig. 2), is of a conical form, and thus the larger pebbles are towards the larger end, and first crush the incoming material, whereas the small pebbles, which naturally congregate at the small end, give the fine final grinding. A further refinement is that the material from the small end of the mill is allowed continuously to flow out through a hollow trunnion, and after being "classified" in an upward flowing current of water, which floats away the finer particles, the coarser particles are returned to the larger end of the mill,

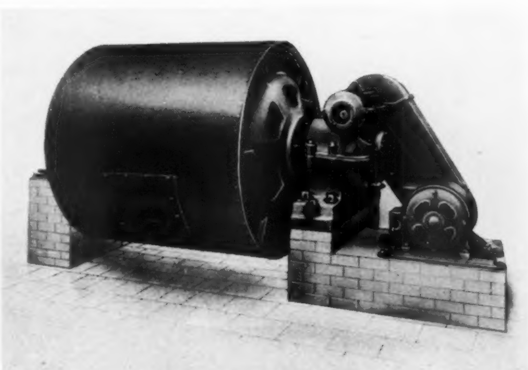

Fig. 1. Ball Mill.

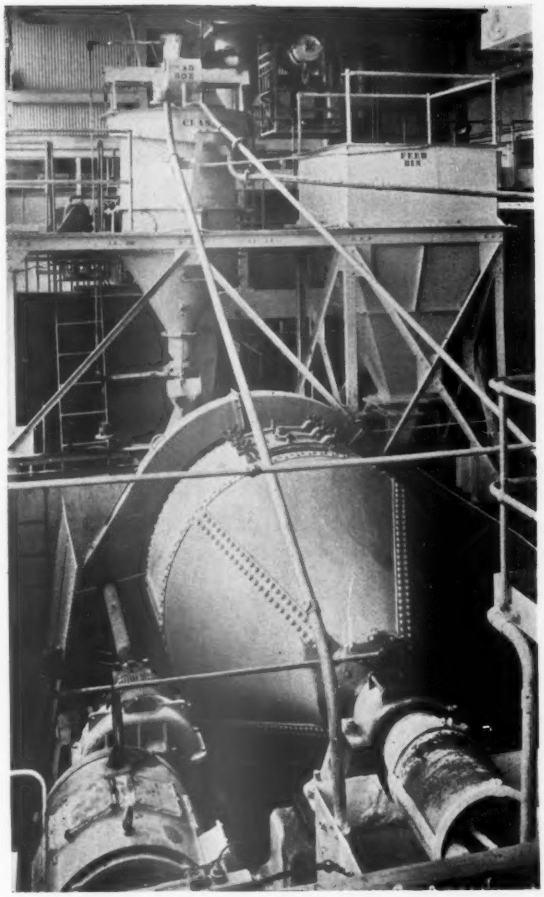

Fig. 2. Hardinge Mill and Classifier.

together with fresh feed, for further treatment, again being introduced through a hollow trunnion.

In the case of flint grinding, the power required to grind one ton to a specified surface factor, is reduced by one half as compared to a single cylinder.

Filter Press

Having purified and blended the "slip" liquid, the ancient potter drove off the water in a shallow heated pan, known as a "slip kiln" and then dug out the result! By pumping the slip into a press (Fig. 3), formed of alternate double layers of cloth, and recessed iron plates, the solid clay is left neatly sandwiched between the double cloths, whence it is easily dropped on to a trolley.

The Pug Mill (Fig. 4) masticates the clay after filter pressing, replacing hand "wedging", which was performed by throwing the clay on to stone slabs, and/or striking with mallets. The pug knives urge the clay forward in a cylinder and, as a refinement, the clay may be extruded in fine threads into a vacuum chamber, being thereby de-aired, for super-plasticity.

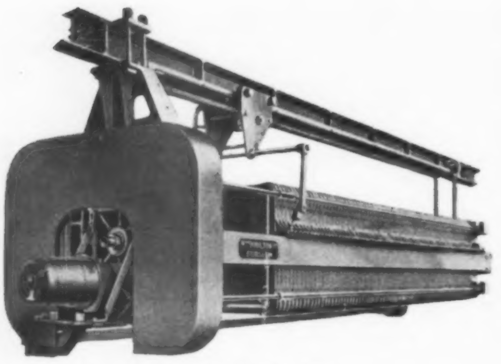

Fig. 3. Filter Press.

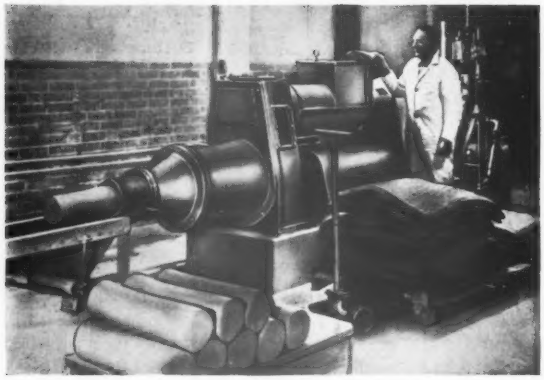

Fig. 4. Pug Mill.

Making Shaped Ware

Cups and flatware are both made by having a clay "bat" pressed against a plaster "mould" surface by a steel tool, whilst rotating the mould. The semi-automatic machine shown in Fig. 5 does the rotation and applies the tool and necessary "ration" of lubricating water, in a self-acting manner. The operator simply feeds in moulds and clay bats. In a further elaboration, moulds are conveyed to the machine by conveyor, and clay is delivered directly from the pug. Fig. 6 shows the cutting off of a clay bat direct from the pug extrusion, and laying this on the plaster mould, subsequent hot pressing of the bat on to the mould, and finish shaping by a rotating form tool, complete the piece. The external appearance of this machine is shown in Fig. 7. The pugs are driven at variable speed by hydraulic motors. Such machines are largely used in the United States for large rates of output, and require to be coupled to large capacity ware dryers, also automatic.

Drying

Whilst in America and in the tile industry, "dry-mixing" has achieved some success, suspensions in water, of clay and glaze, are generally used. The surplus water must largely be removed by drying. In an efficient table-ware pottery, the heat requirement for low-temperature drying may be over twice that for high temperature firing bisque and glost together. It must be remembered that of all substances water has the greatest specific heat, and its latent heat is also high. The best types are the "Dobbin" and "Mangle" constructions, which are illustrated in Figs. 8 and 9. They both feature forced re-circulation of air, for heat economy, absence of "blow-back" to the potter, convenience of putting ware in and taking out, progressive drying in graded zones, and capacity to retain the output of a potter over the drying period necessary, which may be a matter of hours, if warping is to be avoided. Waste heat from kilns is often ducted to dryers, and economy is also achieved by use of steam or hot water from pass out engines or turbines.

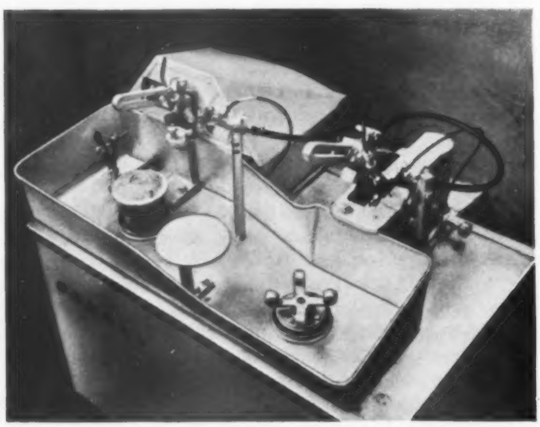

Fig. 5. Semi-automatic Making Machine.

Fig. 6. Automatic Making Machine.

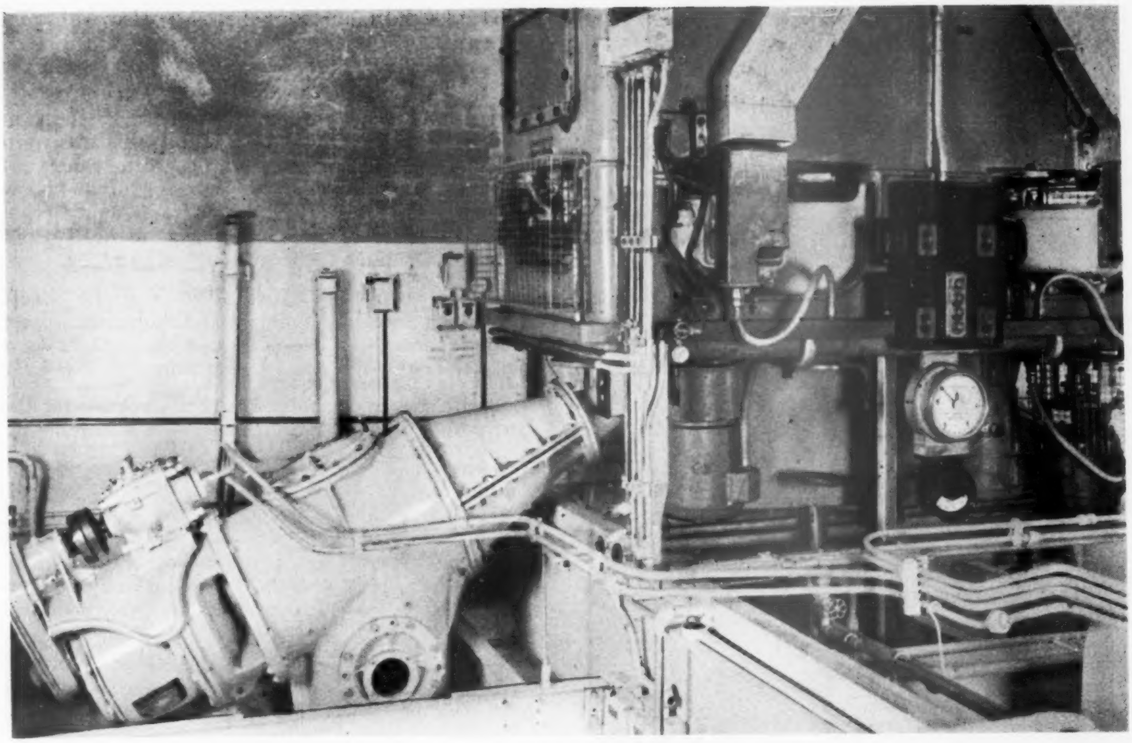

Fig. 7. Automatic Making Machine.

Automatic Turning Machine

The ordinary lathe, with "hand" tools, is the standard simple machine for cups and vases in the green state, before the bisque fire, and imparts a better finish than the "sponging" process. An operator of skill may turn 1 cup/minute. The automatic lathe illustrated in Fig. 10 can turn 4 cups/minute, being fed by quite an unskilled operator. The secret lies in the use of tungsten-carbide form tools, coupled with special vacuum chucking arrangements, using two distinct degrees of vacuum, which hold the quite soft and weak cup firmly against the heavy cutting forces. A sliding sleeve within the cup, after accommodating itself to its individual contour, is locked in position by the centrifugal force of internal lead weights as the chuck starts to revolve. "Conditioning" of the clay to the exactly correct moisture content is essential.

Brushing Machine

After the bisque fire, the sand or alumina used for packing up the ware has to be brushed off. The machine shown in Fig. 11 enables considerable pressure to be applied to the brushes, and as these rotate in contrary directions, there is no tendency to rotate the plate being brushed. In practice, a dust exhaust hood and a perforated tray are built round the working space.

Pressure Cabinet

The transfer-papers used in printing on to pottery have to be smoothed down, and then vigorously rubbed with a very stiff brush, to get the lines to "transfer" to the ware. The energy required has to be "seen to be believed". By use of rapidly-applied air pressure the "transfer" can be achieved equally well, and the cabinet illustrated in Fig. 12 enables ware to be inserted and removed quickly, as the self-sealing door shutter requires neither bolts nor clamps.

Rotary Washing Machine

After transferring the design from a paper print to the ware, the paper has to be removed by "washing off". This process is facilitated by the use of specially-made paper, and the application of special "slosh", or "dope", during the transfer operation. However, there is still a reluctance to immerse the hands in water all day long, so the machine illustrated in Fig. 13 was evolved. The arms slowly rotate, carrying the ware below the surface of the water, and past powerful jets of water. Arrangements are made to skim floating colour specks.

Since the usage of water in a printing shop may be of the order of 30,000 galls./day, recirculation after filtration is worth while.

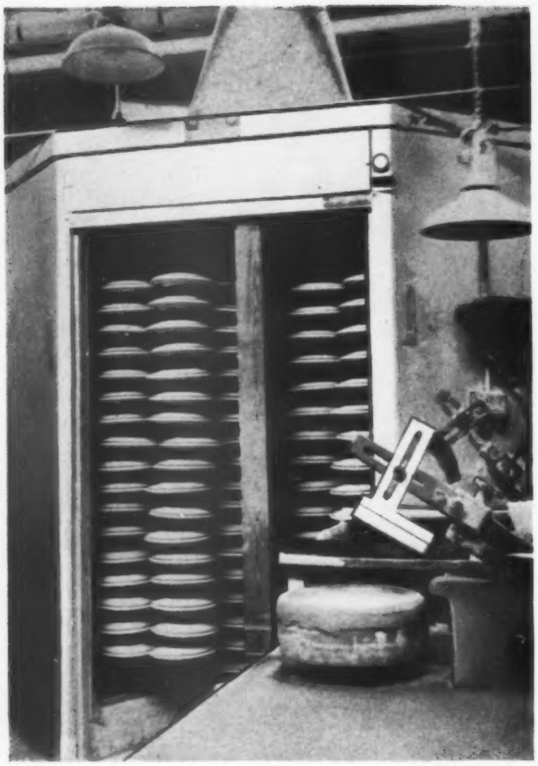

Fig. 8. Rotary Dobbin Dryer.

Lining Machine

Gold or coloured lines on the edges of plates or cups are very often required, either alone, or in combination with other decorations. Great skill is required to get a line of standard quality on all the pieces of a set. The machine shown in Fig. 14 enables two lines to be applied simultaneously, even on deckle-edged ware at a rate of up to 15 pieces/minute. The operator merely places the pieces on the work-head, and keeps the cups filled with gold suspension.

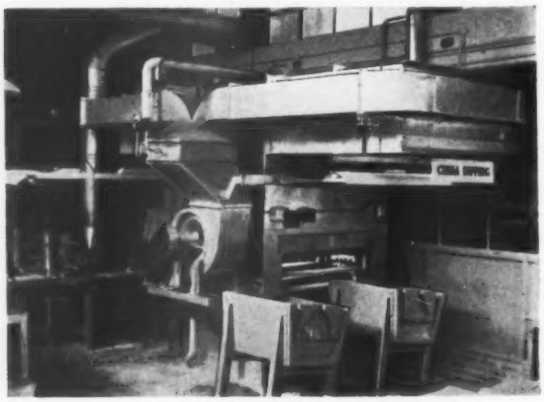

Fig. 9. Mangle-type Dryer.

FURNITURE OR FIXTURES

Neatness, efficiency and strength are essential in modern factories. The old wooden workboards warp so badly as to strain ware in the "green" state. By the use of cast aluminium boards, somewhat hollow on one side, lined with plaster, and kept wet, a moist and true surface is available to keep green ware in "condition" for turning or handling.

Racking is readily provided in a strong, easily dismantled form by tubular scaffolding with light pressed galvanised steel shelves. Fig. 15 shows a rack for holding 50 tons of glost ware.

Steel chairs and tables have been designed for the best possible convenience and working postures.

Great advantage is obtained by the use of the "dumb-waiter" revolving work-feed table for processes such as mould-making or casting, where the worker pours plaster or clay-slip into a number of moulds previously prepared, or for decorators, where a round of work is available ready for one colour or process, before proceeding to do the whole round in the next colour.

Table tops are covered with sheet zinc, or plastic, as being cleanable, non-staining to the ware, and hard wearing.

Fig. 10. Automatic Turning Machine.

Fig. 11. Brushing Machine.

RATIONALISATION

Many rationalising procedures are the especial concern of Time and Motion Study Engineers, who not only study and suggest the best procedures and arrangements for manual work, but also quantitatively measure the savings forecast or achieved.

Good layouts and work-flows, with or without mechanised work-flow, are regarded as essential today. The distance travelled by a piece of clay from Sliphouse to Packing House is astonishing, and may be of the order of three miles, on a factory 250 yards long. A piece of ware, after bisque fire, for glazing and decoration only, may be picked up 330 times (Fig. 16).

All this transport suggests the savings which accrue by the use of mechanical conveying, always having regard to the fact that the ware is " nesh ", or breakable, and also that iron specks from dirty machinery are to be avoided.

Since finished pottery is worth about £90 per ton, the bulk to be handled for a given turnover is high. About half is lost in processing from maker to finished warehouse, and at the clay end, about half the clay issued to the maker is returned to the Sliphouse as " Potters' Returns ". The clay handled is thus one ton for only £22 of sales.

The various types of conveyor used, are illustrated in Figs. 17/21.

Much is to be achieved by the rearrangement of working facilities or, usually, elimination of lack of facilities.

The Mould Maker's Bench, where liquid " plaster in water " is poured into plaster moulds, uses the " dumb-waiter " table. Plaster is conveyed pneumatically in the dry state to an overhead tank, of cyclone form. There is a washing tank for " washing-up " jugs, and a fresh water tank for rapid " dipping out " of mixing water, scales for weighing plaster to mix and, finally, a conveyor to take away finished work. All these facilities are grouped round the worker (Fig. 22).

The Caster's Bench, where clay slip, or suspension in water, is poured into plaster moulds, is provided with slip clay tapped off a ring-main; hot and cold water in " push " taps to sink, with drain; a trough with grill top to drain away surplus slip from moulds standing on the grill, provides the majority of the working surface. The trough drainings are re-blunged for re-use. There is a heated drying stove with exhaust draught, and a grill type exhaust draught to the fettling bench; also a trapdoor for " swept-up " scraps. There is ample fluorescent artificial lighting, and a plug-in point from a centralised vacuum cleaner main, behind the bench. This bench was designed as a direct result of Time and Motion Study of casters working at an ordinary bench, and the cost of providing all services

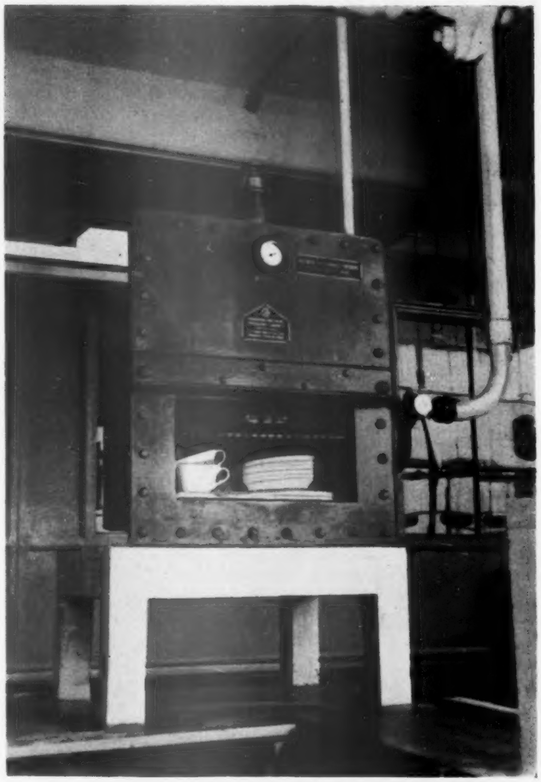

Fig. 12. Pressure Cabinet.

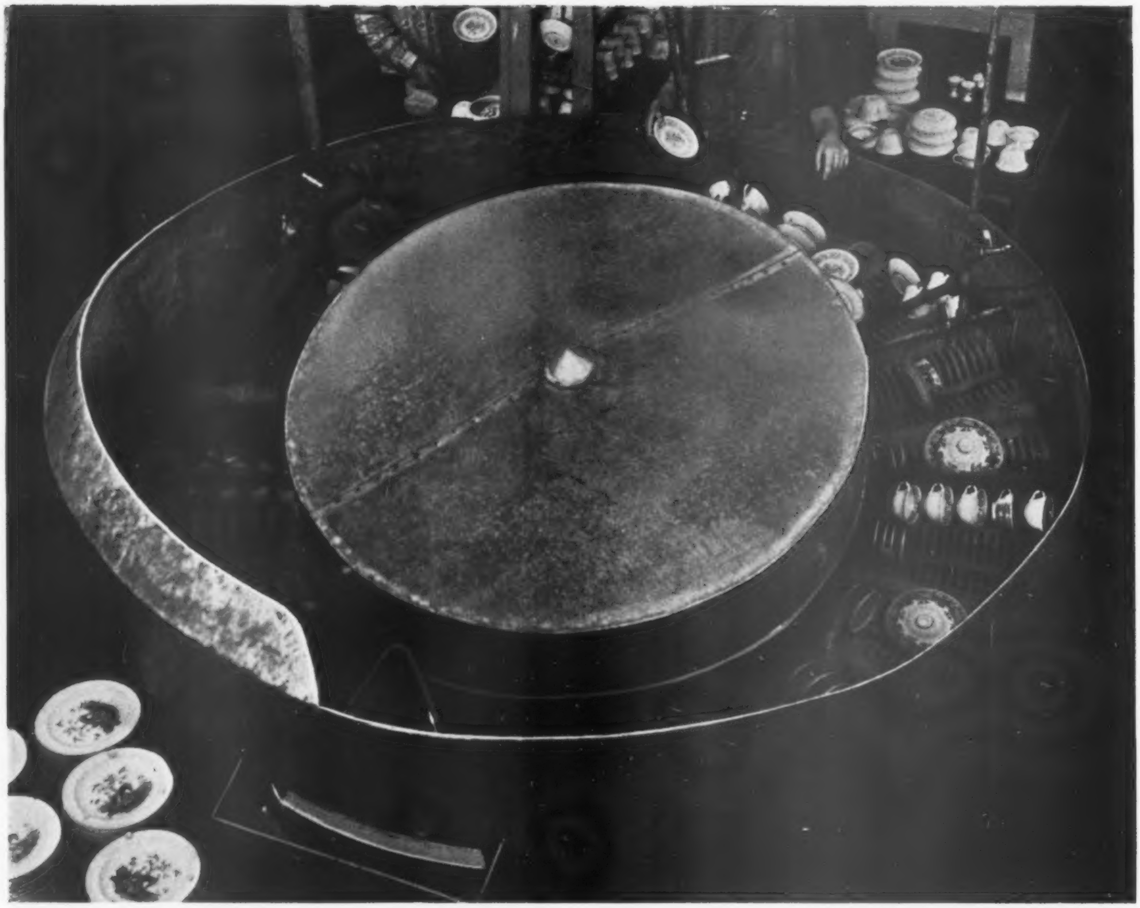

Fig. 13. Washing Machine.

in a comprehensive and really accessible manner, is amply repaid by the better performance of the workers at this essentially craft process.

Flint Calcination, from the 18th century onwards, is performed by heaping alternate layers of flint and coal into a brick chamber, and burning the mass. A rationalised procedure is to introduce flint at the top of a shaft with burners half-way down. An ascending current of air can then be employed as a " heat-vehicle ", firstly, to cool the emerging flint, becoming itself heated, and then, after passing the burners, to preheat the incoming flint. There is an obvious heat-economy by recuperation, and the flint is given a more standard treatment than the old process allows.

Breaking down of the manipulative processes into component parts and re-synthesising, to employ less skilled workers for certain parts, is a fruitful economy measure, best achieved on the basis of Time and Motion Study. Fig. 23 shows a printing workshop where each detail process is performed in sequence. Four rotary hot printing machines feed prints to the central long belts, at which the five main operations: Print Cutting; Print Applying; Sloshing; Whirling; Pressurising, are performed on the ware in sequence. After the washing-off machine, the ware passes down side belts where inspection and " print-mending " is carried out.

PROTECTION

The worker and his work must be protected from a variety of hazards.

The major hazards peculiar to the pottery industry are, for the worker, the dust and silicosis menace and, for the work piece, the specking trouble. There is also a hazard to the surroundings from the uncontrolled emission of dust, or smoke, and also to the adjacent water-courses by the running-off of effluents containing clay in suspension.

The new 1950 Pottery Regulations again step-up the precautions to be taken against dust. In general, dusty processes are to be performed adjacent to a draught hood, and the dust is fan-impelled along ducts, to a filter of textile bags. The efficiency of such filters is remarkable, of the order of $99\frac{1}{2}\%$, and

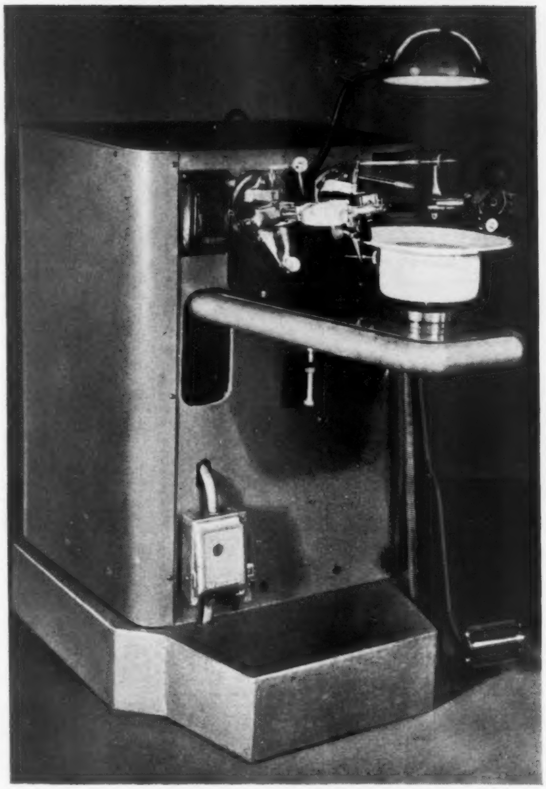

Fig. 14. Lining Machine

there seems no need, in the pottery industry, to consider other types of air filter. Floors, also ledges, are kept clear by the use of vacuum cleaners, in lieu of the older process of sweeping the floor with damp sawdust.

Specking on white ware is a difficulty often intensified by irresponsible mechanisation. A very small particle of iron will enlarge during the bisque or glost fire to give a brown speck and, similarly, copper gives a green speck. Plaster from moulds, refractories used during firing, and concrete from the floor or structure, also cause specks or pinholes and there is, therefore, a considerable technology of specking, to enable this trouble to be traced to its source, with a view to its elimination.

The engineer's contribution has been the provision of high intensity magnetic devices, first dividing the clay slip, or glaze slip, into thin streams, and then magnetising the iron particles to one side. Very feebly magnetic substances, such as iron pyrites, can now be removed. So far, unfortunately, no process for extracting copper specks has been devised. Dipper's glaze tubs are purified by circulating glaze over a sieve, and magnet. Magnets can be attached to particularly troublesome parts, such as overhead monorail conveyor rails, to secure abraded iron as and when it is formed. Special dust extractors, for pneumatic sweeping of ware already dottled (or built up into stacks) before the glost fire, are very useful.

From the Sliphouse and Dipping House, there are always ark-washings and floor washings, containing such fine ceramic particles, that simple settling in lagoons does not render the effluent sufficiently clean to discharge into rural water-courses. A certain acceleration of settling rate by flocculation can be made by chemical dosage to adjust the pH value to an optimum figure, or the whole of the effluent can be filter-pressed, but a more modern method is to utilise a " thickener ", where a very low upflow rate encourages solids to settle, and rakes on the bottom impel the settled solids to an outlet for removal (Fig. 24).

INSTRUMENTATION

In common with all process industries, the potter finds the need to *measure* various properties or qualities, to explain variation in his products. As a further step he requires to *control* these, to ensure continuity of quality, or even of size.

The tunnel kiln itself, with its continuously recurring firing cycle, is evidence of the need for standardisation. Recording and controlling pyrometers maintain steady temperatures along the length of the tunnel, and accurately calibrated pushing " engines " ensure that the trucks move at the standard rate through the temperature zones. A view of a modern electrical tunnel kiln is shown in Fig. 25.

Humidity conditions and moisture content of the ware are very important where pieces are stuck together in the green state, as handles and feet on to cups, spouts on to teapots, or embossed ornaments

Fig. 15. Steel Rack.

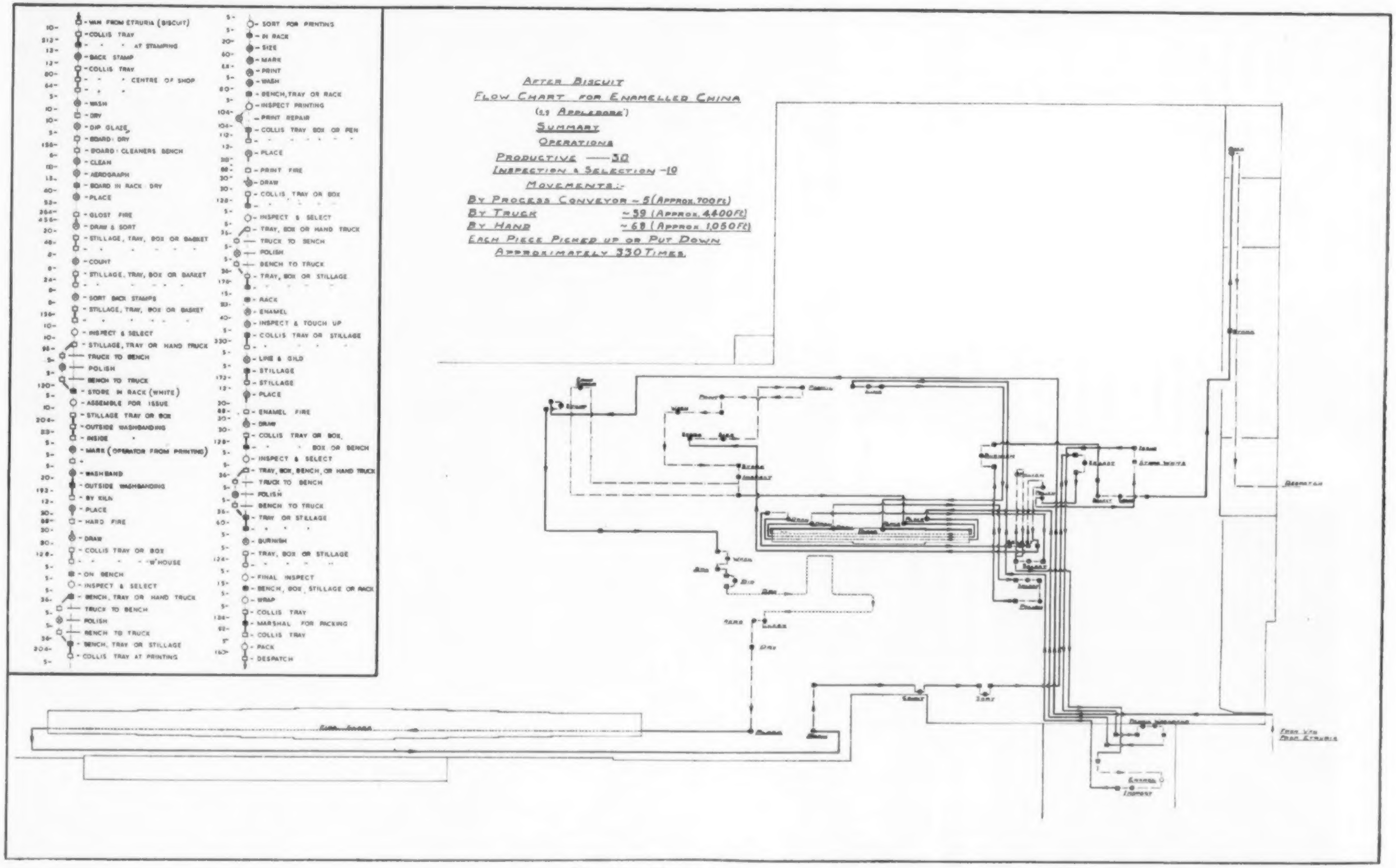

Fig. 16. Flow Chart.

Fig. 17. Monorail Conveyor.

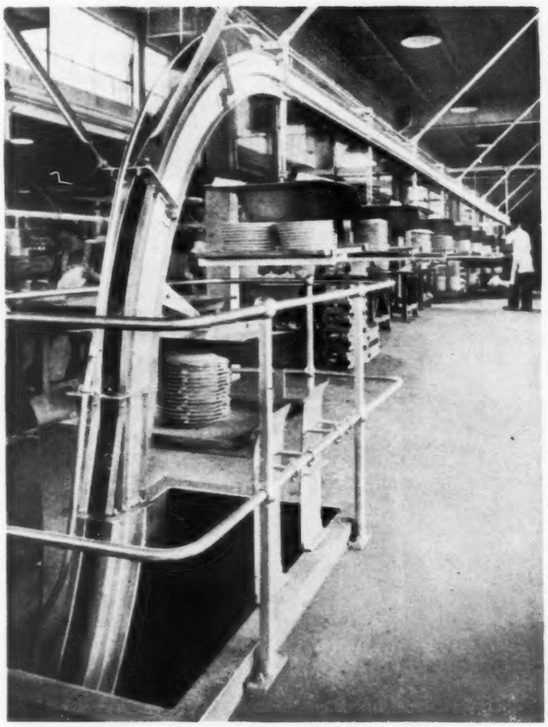

Fig. 18. Flowlink Conveyor.

on to ware generally. A variety of instrument-controlled humidifying machines have been evolved for this purpose.

Mixing of various body recipes is accomplished by having each material in a water suspension, or "slip", and mixing the slips by volume. It is thus necessary to know the solid content of each slip beforehand, and this was formerly accomplished by taking an average sample of each bulk, and weighing one pint to give the "pint weight", or specific gravity. A more elegant method is simultaneously to weigh, and measure the volume of, a quantity of suspension, when deduction of the weight of the calculated volume of water, yields the weight of dry solid present (Fig. 26).

In milling operations, where several mills are to be charged with given weights of solid materials drawn from a variety of overhead hoppers, a travelling overhead crane gives the necessary movements to a container, over the whole area of the mill, by two-dimensional traversing, and carries the container (actually of stainless steel) on a weighing machine.

Due to slight variation in the degree of shrinkage during drying and firing, it may be impossible to fit a decorative transfer sufficiently accurately to the rim of, say, a plate, for all pieces. Consequently, a selection has to be made for "size-groups" on all ware coming from the bisque fire. Mechanical gauges facilitate this grouping in a rapid and expeditious manner. A gauge with multi-coloured "zones" of size is shown in Fig. 27.

Fig. 19. Mangle Conveyor.

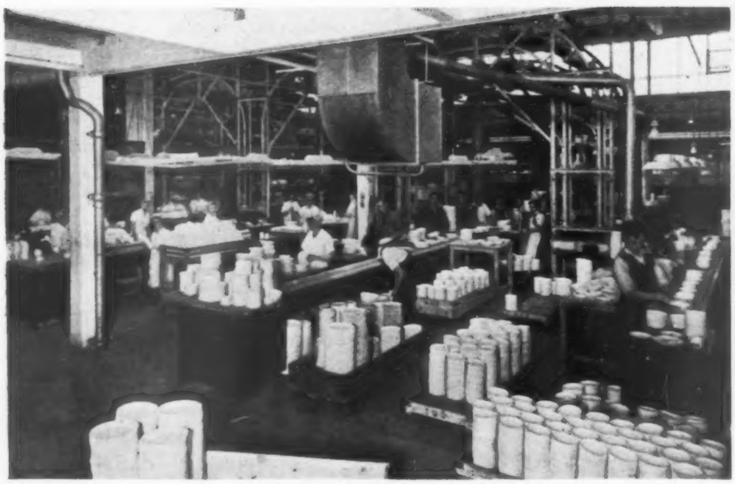

Fig. 20. Belt Conveyors.

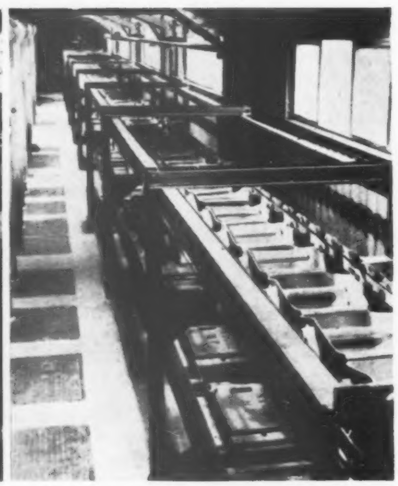

Fig. 21. Bucket Conveyor.

Fig. 22. Mouldmaking Shop.

PROCESSES BARELY POSSIBLE BY HAND

Even the most ingenious and resourceful potter would be puzzled to perform by hand, or with simple hand tools, certain processes readily accomplished now by engineering equipment.

The most elegant form of firing today is the electric tunnel oven, using the electricity produced by engineers, and enabling the potter, to a degree impossible with other fuels, to "place open" even the most delicate decorated glost ware, that is, dispensing with a saggar or fire box (thus improving the rate of heat transfer to the ware), and obviating the heating up of quantities of refractory material to no purpose. The ovens are heated by resistance elements, either nickel chrome, kanthal, or silicon carbide, the latter requiring continuous voltage regulation by variable ratio auto-transformers.

Even the elementary potter's wheel is an engineering device, and hence all circular pieces require some machine for their production, but the method used for producing an oval dish by machine is striking in its ingenuity and compactness (Fig. 28). Two slides fixed at right angles are mounted below the table of the machine. A slipper in the lower slide, which rotates about an axis displaced from the axis of the other, causes the table itself to rotate in such a manner that at one point a fixed tool describes an ellipse on the table. By varying the distance between the axes of rotation, the ratio of major to minor axes of the ellipse is varied, whilst the size of the ellipse varies by displacing the tool away from the axes. Actually, the table centre moves in a circular path, but at *twice* the speed of rotation of the table round its centre.

It is interesting to note that the early potters produced a shape more flat-sided than a geometric ellipse. The æsthetic merits of the two shapes are said to be beyond the mere engineer's comprehension, and require the artist's perception to decide which is the more attractive.

The provision of splines or flutes round a circular object is essentially a job for a machine, particularly if the object is neither cylindrical nor conical, but produced by a curved trace, as in the case of vases.

By use of a relieving lathe with a form tool, the cutting of splines, even in pitching and depth, with sharp edges and a good surface finish, is rendered possible. By first coating the article with a coloured engobe, and then cutting this away on such a machine to reveal the under-body, very attractive effects are rendered possible.

Another process not possible by hand methods is the repairing of glaze coatings by depositing atomised glaze from a compressed air gun. Ordinary dipping of the bisque article in a tub of glaze suspension in water, produces, even with a skilled operative, a coat which is only approximately uniform. For superfine quality ware, however, particularly where there is heavy embossment incorporating also fine detail, it is necessary to "ware-clean" off the surplus glaze, and then repair the coating by a mist from the gun. It is also possible to do the whole "dipping" process by aerographing, as in an automatic glazing machine, using a multiplicity of guns (Fig. 29).

Bone China has to be fired to the soft vitreous state to get the required translucency. Consequently, flat ware slumps down on to whatever supports it during the bisque fire. Generally, a plaster tool was used to form a shaped "bed" in powdered flint or alumina. The "bed" was used once only, and had a certain resilience which did not make for accuracy. A permanently accurate bed, which can be used over and over again, offers definite advantages, particularly in the matter of the closest possible spacing of ware to economise in valuable oven space. Modern refractory techniques produce a bedder which is stable in shape and size after many firings at china bisque temperatures, or 1,300°C. roughly.

Unfortunately, the firing of these refractories in the first instance, naturally at an even higher temperature, causes shrinkage and warping which means that the shaped surface is not good enough for the purpose intended. Accordingly, a "form-grinding" process is carried out, and in spite of the presence of somewhat large nodules of hard "grog", produces a good accurate surface. The life of such beds is hundreds of fires.

Fig. 23. Printing Shop.

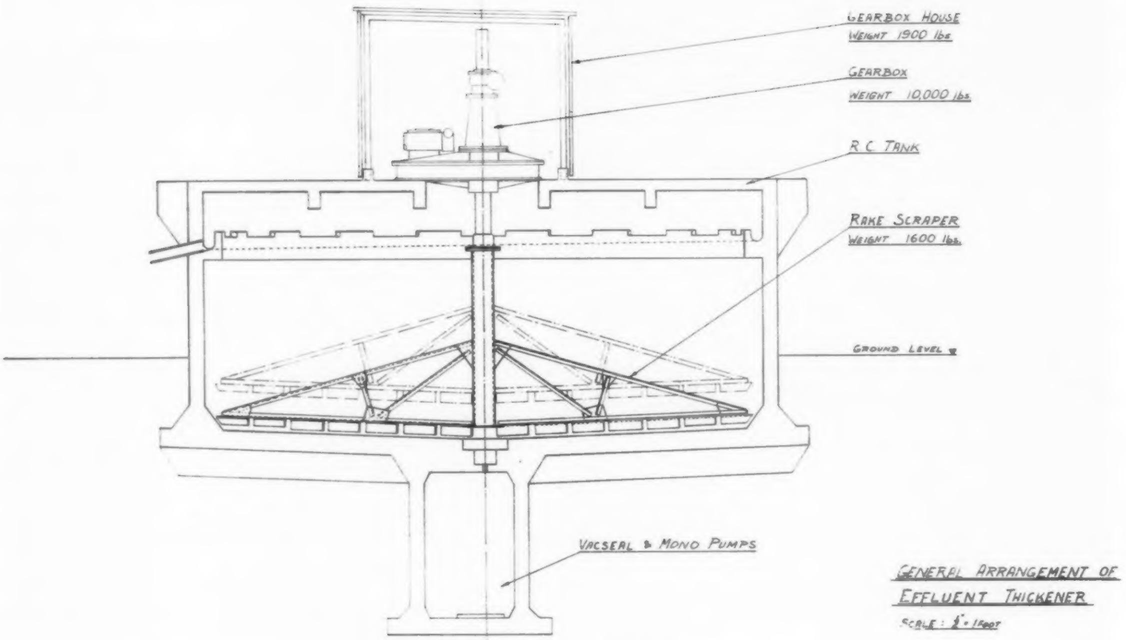

Fig. 24. Effluent Thickener.

WHAT OF THE FUTURE ?

It is interesting to speculate in what directions development may proceed in years to come, in that the engineer is certain to be concerned closely therein.

In the case of general factory amenities, probably noise reduction is overdue for consideration. Most operatives on delicate processes are very sensitive to noise level; the hum of fans, and the roar of burners, will have to be reduced from the " industrial " to " domestic " levels.

In view of the expense of getting rid of surplus water from clay slips and plastic clay goods, dry mixing has been tried, notably in the United States. This will naturally call for raw materials in the dry state, probably delivered in paper sacks, milled to a specified surface factor. Articles may be formed, in lieu of jiggering or casting, by dry-pressing powders in metallic dies, similar to the methods used for electrical porcelain today. In any case, the use of Plaster of Paris for moulds has numerous disadvantages, in the way of limiting permissible drying temperatures and the shedding of abraded particles, or powder, on to the ware being dried. The cost of mould turnover for articles with embossments is very heavy. Sintered porous metal moulds may eventually replace plaster for quantity production.

The crying need of the table-ware industry, however, remains at the " decorating end ". However much embossment, fancy glazes, coloured slip dips, or coloured bodies are used, there is still a great demand for coloured designs, and gold or lustre applications. Here the multi-coloured, lithographic-printed transfer and the sprayed-on coat of colour have vastly simplified quantity production. Still there remain possibilities, such as direct photography, perhaps in colour, on to the surface of the ware. Offset gold printing on the ware has possibilities,

Fig. 25. Truck at entrance to electrical tunnel kiln.

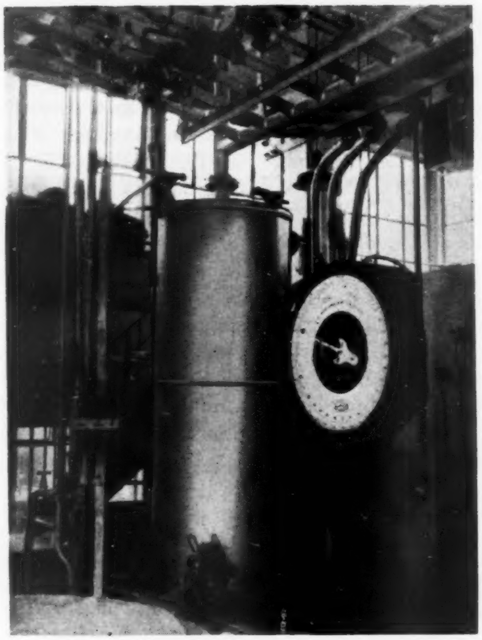

Fig. 26. Slip Weigher.

Fig. 27. Size Gauge.

Fig. 28. Elliptical Motion Slides.

Fig. 29. Automatic Glaze Spraying.

but requires to be perfected if it is to use " best gold " and be capable of passing really stringent selection. Gold edge and inner lines are applied mechanically, but not speedily for the " best gold " work. Hand groundlaying and hand enamelling remain the standard processes today for quality decoration.

I trust that this address may stimulate the interest of Production Engineers in the potting industry and show that developments based on engineering principles and techniques are continuously being applied to the ancient craft. You may even call for more specialised Papers dealing, much more thoroughly than has been possible here, with specific facets of the work of the engineer for the potter. It will be realised that the examples given are only a few drawn at random from this rapidly modernising industry, and those of a particular group of potters who are engaged in a small field, but a very powerful dollar-earning field, which is what seems really to matter today. Another group, such is the fascinating variety of this craft, would produce quite other types of examples of the engineer's help.

Acknowledgments

In conclusion, I must express appreciation to those friends who have so kindly loaned illustrations and provided descriptive material relating to their products, including, The Aerograph Co. Ltd., Messrs. Bagshawe & Co. Ltd., The Blending Machine Co. Ltd., Messrs. W. Boulton Ltd., Messrs. British Brown Boveri Ltd., Messrs. Edwards & Jones Ltd., Messrs. Fisher & Ludlow Ltd., The International Combustion Co. Ltd., Messrs. Malkin Ltd., Messrs. Steele & Cowlishaw Ltd., Messrs. Sulzer (London) Ltd., and in particular the Board of Messrs. Josiah Wedgwood & Sons Ltd., of Barlaston, for their encouragement, permission to illustrate devices used in their factory, and for the provision of samples of work. I would also like to thank Mr. Swinnerton, Secretary of the Wedgwood Camera Club, who has prepared the illustrations.

AUTOMATIC LOOMS AND THEIR APPLICATION

by F. C. SHELDON

An Abridgement of the Lecture given to the Manchester Graduate Section of the Institution, 17th April, 1953

HISTORY shows that the weaving craft is one of the oldest in the world and there are records of the craft being developed by the Chinese, the Indians and even the Incas of Peru, while Biblical history shows that the weaving of fine textures was carried out in Egypt, as confirmed by discoveries in Egyptian tombs.

Forms of weaving follow from the earliest type of hand loom to the power loom, as developed by Cartwright, and thence to the automatic loom. Earliest types of the latter were the shuttle changer, as invented by Jackson, to be followed by Northrop's invention perfected in America and eventually applied universally. These men helped to revolutionise the weaving processes.

Definition of an Automatic Loom

The automatic loom is a term applied to a loom fitted with a mechanism for automatic replenishment of the weft to ensure continuous running and to enable the weaver to tend more looms. The loom, in addition, has a warp stop motion, positive take-up motion with automatic let-back, and automatic let-off motion. The loom also contains essential primary motions common to both automatic and non-automatic power looms, such as the picking motion, the crankshaft and slay; shedding by plain and twill tappets, dobby and jacquard.

Having seen and discussed the single shuttle type of automatic loom and observed its variety of mechanisms, we now turn to the maker's point of view in producing these combinations to suit not one, but many types of raw material, and the variation in yarn diameters such as occurs between single cotton yarns of medium count and cabled yarns of coarse count. The problem does not end with the single shuttle loom. The next stage was the development of the automatic box loom, that is, one where different colours are introduced into the weft by mechanical control of several shuttles. Here, the selection and ultimate transfer of the right colour, according to the shuttle in operation, introduced considerable complication for the inventor, yet this is solved in a design which is mechanically efficient and simple to maintain. The various features of the box loom comprising the 4-colour magazine, the all-electric feeler, the mechanical-electric feeler, a D.C. supply circuit with leakage indicator and the centre weft fork motion are all illustrated.

Application

The pre-requisites to the application of automatic looms are weaveable raw material and counts or fibres not so excessively coarse as to nullify the labour-saving devices.

The automatic loom has a wide application for standard fabrics in every-day use, but it involves the introduction of a system as well as a machine; it requires suitable conditions of operation for the weaver in the weave room and examples of this are illustrated. The importance is stressed of providing good raw material by thorough and painstaking preparation in pre-weaving processes.

Earlier attempts to introduce this machine provoked opposition from both manufacturer and operative, the former because of cheap labour and the latter because of fear of unemployment. The famous Platt Report which came out after World War II, based on the observations of the British Textile Mission to the U.S.A., acknowledged that only 5% of the looms installed in the United Kingdom are automatic, and it is doubtful now whether the figure is higher than 15%, whereas the Continent of Europe took up automatics on a wide scale and the percentage of automatic cotton looms in Sweden is reputed to be 80%. The fact that our inventors had to find a backing abroad and then discover that the product of their genius was not even acceptable in their own country is a deplorable reflection.

The tendency to regard exports of modern automatic looms as inimical to the nation's interests overlooks the fact that if Britain does not supply them, another country will, and 26 existing makers of automatic looms are quoted in the world today. The loss of sales could not justify the attitude.

Design

The maker has to cater for the variable factor of raw material, variations in processing and the human element. The basic principle of the loom is a bad one, since it involves throwing a shuttle at relatively high velocity, stopping it accurately and then repeating the process up to 220 times per minute. Design has to be related to the work to be performed, and above all to the price at which the product has to be sold. Any attempt to let luxury of technique dictate can only be to the disadvantage of the price of the unit. Speed has not advanced greatly over the years, but the consideration is the speed that gives the highest production from the raw material available and with the lowest maintenance costs. Accessibility must also be to the fore where only semi-skilled engineering labour may be available.

Conclusion

The case for the automatic loom is proved. Its future is bright and its purpose noble. The United Kingdom is in the forefront of the development of future design. Shuttleless looms are referred to, but the case for the wide replacements of the orthodox design of shuttle and picking motion has yet to be established. Gledhill's patent is referred to and illustrated.

Stress is laid on the vital need for automatic looms in the weaving industry in this country and this is emphasised by the report recently issued by the United States Textile Mission to Lancashire. The ordinary power loom is a museum exhibit in the United States and Britain cannot hope to maintain her standard of living and support a welfare state unless she is prepared to keep pace with this essential development of high productivity in the weaving shed.

NOTE :—*The full Paper, complete with illustrations, is available on loan to members from the Hazleton Memorial Library.*

PRODUCTIVITY MEASUREMENT IN SWEDEN

The British Productivity Council recently approached the Institution in regard to a request they had received from The Federation of Swedish Mechanical Engineering Industries (Sveriges Mekanforbund) for an English lecturer to take part in a Conference on Productivity Measurement being held in Stockholm.

The Institution put forward the name of Mr. B. H. Dyson, Member of Council, Joint Chairman of the Joint Committee and Deputy Chairman of the Research Committee, who has specialised in the field of productivity measurement.

Mr. Dyson attended the Conference in Stockholm on 7th May and spoke on the practical aspect of productivity measurement in British industry. Another speaker at the Conference was Mr. Einar Hardin, Swedish Economist, who dealt with the theoretical aspect of productivity measurement.

Mr. Dyson reports that about 150 people attended the Conference, many of them Directors from well-known Swedish companies such as Ericsson Telephones, Electrolux, Skefko Ball Bearings, etc. The members of the Conference were well acquainted with the Anglo-American Productivity Reports and had also taken advantage of visits to America for the purpose of comparing productivity. They were, however, more particularly interested in conditions appertaining to British industry, which they felt to be more in line with their own and therefore offered greater opportunities for comparison and improvement.

It is interesting to note that the Institution's Measurement of Productivity Reports issued by the Joint Committee were well-known to members of the Conference, and while, of course, Mr. Dyson made particular reference to them in his address, so also did one of the Swedish speakers, Mr. Einar Hardin.

INSTITUTION NOTES

GRADUATE CONVENTION, 1953

A one-day Graduate Convention is being arranged by the Birmingham Graduate Section and will be held at the University of Birmingham on Saturday, 5th September, 1953.

The theme of the Convention, which is the second to be organised by this Section, is "*Engineering Production — Responsibilities and Opportunities*", and its aim is "to inspire the Graduate of the Institution by giving him an appreciation of the breadth of his job, its responsibilities, its achievements and its possibilities for the future".

Three addresses will be given, as follows:

"Economic Factors in Engineering Production"
Speaker: Mr. Ian Morrow, C.A., F.C.W.A.

"Human Factors in Engineering Production"
Speaker to be announced later.

"Review and Outlook for the Future"
Speaker: Mr. Walter C. Puckey, M.I.Prod.E., F.I.I.A., President of the Institution.

The proceedings will be summed up by Sir Cecil Weir, K.C.M.G., K.B.E., M.C., immediate Past President of the Institution.

While the Convention is intended primarily to provide a meeting place for Graduates and Students at which they may listen to some stimulating and thought-provoking addresses and discuss their responsibilities, status and task for the future, all those who are interested are invited to attend. Application for tickets may be made on the form included with this Journal, where full particulars of the programme will be found.

1953 SUMMER SCHOOL

An advance notice and application form for the 1953 Summer School, which will be held at Ashorne Hill, near Warwick, from the 26th to 30th August, was enclosed in the April Journal.

The theme for the School is "Work Study" and the number of applications received is considerably in excess of the demand in previous years, so that only a limited number of vacancies for full-time attendance are now available. Further copies of the advance notice and application form can be obtained from the Secretary, 36, Portman Square, London, W.1.

NEWS OF MEMBERS

CORONATION HONOURS

The Institution records with pleasure the following awards to members:—

O.B.E. Mr. W. C. Swift, Member, Assistant Director (Engineering), Ministry of Supply.

M.B.E. Mr. A. H. Blackwell, Member, Director and Works Manager, David Brown Tractors, Ltd., Metham, Huddersfield,

and

Mr. J. Buckley, Associate Member, Works Manager, Thomas Robinson and Son Ltd., Rochdale, Lancs.

MR. T. GILBERTSON

Mr. T. Gilbertson, Member, Director and General Manager of Folland Aircraft Limited, Hamble, is making a tour of aircraft factories in the United States and Canada.

Mr. T. Gilbertson

Mr. Gilbertson is a member of the Southern Section Committee, and was one of the main speakers at the Conference on "Problems of Aircraft Production", held at the University of Southampton, last December.

NEW APPOINTMENTS

MR. C. C. BATES

Mr. C. C. Bates, Associate Member, has been appointed Chief Welding Engineer of Costain-John Brown Ltd., London, W.1. In addition, he will be responsible for the technical supervision of Welding Supervision Ltd., their associate company.

Mr. C. C. Bates

Mr. Bates joined Costain-John Brown Ltd., from the British Welding Research Association where, for the past four years, he was one of the Senior Development Engineers responsible for helping industry apply the results of research and member firms with design, technique, metallurgical and inspection welding problems.

Prior to joining B.W.R.A., Mr. Bates was with Under Water Welders & Repairers Ltd., following eight years in the Ministry of Aircraft Production and Ministry of Supply.

MR. E. J. H. JONES, M.B.E.

Mr. E. J. H. Jones, Member, General Manager of Crossley Motors Ltd., Stockport, has been appointed to the Board of that Company.

Mr. E. J. H. Jones, M.B.E.

Mr. Jones has a long record of valuable service with the Institution, having served on Council and a number of Standing Committees for many years. He was elected President of the London Section in 1933 and in the same year was awarded the Institution's Medal for the best Paper presented by a member. He is also the author of the book "Production Engineering—Jig and Tool Design", of which five editions have been published, including one in the United States.

Mr. Jones was until recently actively concerned with the activities of the Production Engineering Research Association of Great Britain, a Governor of the Southall Group of Technical Colleges and a member of the Executive of the London Association of Engineering & Allied Employers' Federation; he has now been elected to the Manchester Area Executive of that Federation.

MR. J. P. FORD

Mr. J. P. Ford, M.A., Associate Member, Director of Brush Export Ltd., has been appointed General Manager of that Company. He is also Director and General Manager of Associated British Oil Engines (Export) Ltd., and of National Oil Engines (Export) Ltd., and is on the Board of BRUSH ABOE (Ireland) Ltd., and of Associated British Oil Engines (Marine) Ltd. He was previously General Manager of British Engineers Small Tools & Equipment Co. Ltd., (BESTEC), and of Scientific Exports Great Britain Ltd. (SCIEX), from their inception in 1945 until he joined the BRUSH ABOE Group in 1949.

Mr. J. P. Ford

Mr. Ford has been Vice-Chairman of the Institute of Export since 1949, and a Council Member of the London Chamber of Commerce since 1951.

MR. A. G. HAYEK

Mr. A. G. Hayek, Associate Member, until recently with Thackwell & Hayek Ltd., has now formed a new Company, A. G. Hayek & Partners Ltd., Management Consultants and Industrial Engineers, with head offices at Federation House, Stoke-on-Trent.

Mr. A. G. Hayek

Mr. Hayek is Vice-Chairman of the Institution's Sub-Committee on Materials Handling, which is about to publish a Review of Materials Handling Practice in British Industry, based on investigations carried out during the past two years.

MR. A. WOOD

Mr. Arthur Wood, Member, has been appointed to the Board of Henry Meadows Ltd., Wolverhampton, and H. Widdop & Co. Ltd., Keighley.

Mr. A. Wood

Mr. Wood is Managing Director of C. E. Johansson, Ltd., Dunstable, Beds.

Mr. M. F. Avery, Associate Member, has now taken up the position of Chief Rate Fixer at Hayward Tyler & Co. Ltd., Luton.

Mr. N. H. Bradbury, Associate Member, is now Lecturer in Electrical and Mechanical Engineering at King's Lynn Technical College, Norfolk.

Mr. C. Ellis, Associate Member, has been appointed a Special Director of Edward Pryor & Son, Ltd., Sheffield.

Mr. P. A. Fryatt, Member, has transferred from Rolls Razor Ltd., Cricklewood Broadway, to their new Dry Shaver Factory at Hemel Hempstead, as Works Manager.

Mr. A. E. Groocock, Associate Member, has resigned his position as Executive Production Engineer to the J. & H. McLaren, Leeds, plants, and has emigrated to Canada.

Mr. A. W. A. Kay, Associate Member, has been appointed a Director of Gerhardy Bros. Ltd., Gt. Missenden.

Mr. Aubrey Lewis, Member, has been appointed General Works Manager of The Pyrene Co. Ltd., where he was formerly Works Manager.

Mr. T. F. Newton, Associate Member, has been appointed Factory Superintendent of Edward Pryor & Son Ltd., Sheffield.

Mr. J. D. Roberts, Associate Member, is now Works Manager of Windolite Ltd., Harlow.

Mr. J. J. Southwell, Associate Member, has relinguished his post with Nash-Kelvinator Ltd., and has taken an appointment as Field Engineer with H. H. Fraser & Associates (Pty.), Ltd., Johannesburg.

Mr. D. W. Spurging, Associate Member, has left Philips Electrical Ltd., and is now Methods Superintendent with English Electric Ltd., at their new Marconi's Basildon Works.

Mr. C. Taylor-Cook, Associate Member, has been appointed Principal of Poplar Technical College, London, and will take up his duties there on 1st September, 1953.

Mr. T. L. Udall, Associate Member, is now Lecturer in Production Engineering at the new Technical College, Hatfield.

Mr. Kenneth Walker, Associate Member, formerly Assistant Production Engineer with The Laycock Engineering Co. Ltd., has now been appointed Works Director.

Mr. W. N. Axtell, Graduate, is now employed as a Draughtsman with De Havilland Propellers Ltd., Hatfield, Herts.

Mr. J. G. Crofts, Graduate, is now a Service Engineer with J. Brockhouse (Rhodesia) Ltd., Salisbury, Southern Rhodesia.

Mr. D. J. I. Gray, Graduate, of the Yorkshire Graduate Section, has emigrated to New Zealand and is now working in Dunedin.

Mr. D. R. C. Holmes, Graduate, has relinguished his post with the Mid-Essex Technical College and is now an Assistant Grade B at the Twickenham Technical College.

Mr. J. Walker, Graduate, is now a Tool Designer with the Ford Aircraft Engine Division, Chicago, Illinois.

BRITISH STANDARDS

The following Standards have recently been issued, and may be obtained, post free, at the prices stated from the British Standards Institution, 24-28, Victoria Street, Westminster, London, S.W.1 :—

969 : 1953	Plain Limit Gauges, Limits and Tolerances (3/6d.).
1971 : 1953	Corrugated Furnaces for Cylindrical Boilers (5/-).
1974 : 1953	Large Aluminium Alloy Rivets (4/-).
1978 : 1953	Bit Braces (3/-).

Issue of Journal

Owing to the fact that output has to be adjusted to meet requirements, and in order to avoid carrying heavy stocks, it has been decided that the Journal will only be issued to new members from the date they join the Institution.

JOURNAL BINDERS

Members are advised that binding cases for the new size Journal are now available, and may be ordered from Head Office. The cases, which are strongly made and covered in dark red leather cloth, with "The Institution of Production Engineers Journal" in gilt on the spine, will each hold 12 copies of the Journal. The price per case is 10/-, post free.

A limited number of binding cases for the old size Journal are also available, at the reduced price of 2/6d. per case, post free.

Research Publications

A number of copies of the following Research publications are still available to members, at the prices stated :

Report on Surface Finish, by Dr. G. Schlesinger	15/6
Machine Tool Research and Development	10/6
Practical Drilling Tests	21/–

These publications may be obtained from the Production Engineering Research Association, "Staveley Lodge," Melton Mowbray, Leics.

HAZLETON MEMORIAL LIBRARY

Members are asked to note that the Library will be open between 10 a.m. and 5.30 p.m. from Monday to Friday each week. Due to Meetings, the full facilities will not be available at the following times during this month :—

Wednesday,	8th July	from midday		Thursday,	9th July	all day
Thursday,	23rd July	all day		Tuesday,	28th July	from 2 p.m.

It would be helpful if, in addition to the title, the author's name and the classification number could be quoted when ordering books.

REVIEWS

658.7 BUYING : STORING

" Stock Control and Store Keeping : Formerly BS 1100 : Part 5." *British Institute of Management, London. Rev. ed. London, the Institute,* 1952. 60 *pages, diagrams.* 5/- (*Production Management Series* 5.)

Written primarily for the small to medium sized firm, this booklet will give considerable food for thought to those in industry engaged upon controlling and caring for manufactured goods.

The necessity of, and the methods employed in, stock control are dealt with in the first sections of the booklet. The wide variety of records and forms that accurate control demands, are explained simply and line diagrams are used to show suggested lines of authority and functional responsibilities.

Stores, Storage and Storekeeping are discussed in the second half of the book, and considering the wide requirements of industry due to the different types of products, the treatment throughout is such that the suggestions made are almost universally applicable.

Some interesting observations are made regarding stocktaking and also the types of personnel required for stock control and storekeeping.

A useful bibliography is included, for once having read this publication, the reader will be tempted to read further literature on this all important subject.

H.G.P.

658 INDUSTRIAL ORGANISATION : MANAGEMENT

" The Executive at Work " by Melvin T. Copeland. *Cambridge, Mass., Harvard Univ. Press,* 1952. 278 *pages.* £1 4s. 0d.

Amid the widespread discussion concerning the necessity for improved industrial efficiency and the methods through which improvement can be achieved, Mr. Copeland's book provides a timely reminder of the importance of executive leadership in the matter. He states that the purpose of his book is " to discuss the elements of executive achievement." From a lifetime of varied experiences, he draws upon many practical examples to illustrate the principles of administration and organisation and to outline the qualities necessary for the attainment of executive leadership. Although the book deals primarily with executive leadership in corporate business enterprises, the principles and conclusions in general hold good for many other kinds of enterprise.

In setting out the job of an executive, the author deals in some detail with the diversity of the problems and responsibilities with which the executive is faced. Responsibilities for the selection, instruction and guidance of his staff; for securing efficient team work and effective communication and control within the organisation; for exercising foresight to meet changing conditions; for the timing of action; for building morale; and for retaining an active interest in activities which help improve his effectiveness and outlook.

The task of the executive is a difficult one, calling for a scarce combination of abilities. The assumption of many responsibilities does not automatically vest the executive with authority to discharge them. Real authority must be won by the action of the executive himself. This involves the ability to understand and size up people; to stimulate them to effective action; and to exercise mature judgment in dealing with a wide range of problems.

The author emphasises that the executive's task requires courage—to act decisively and promptly, particularly in an emergency; to admit mistakes which have been made; to face new problems and conditions imaginatively; and to be resourceful in finding means to carry out decisions. In turn, courageous decisions require both moral and physical stamina.

Within the final chapters of this book the author considers the rewards for the executive, provision for retirement and the present-day trends which threaten to limit freedom for achievement.

Viewed against our own social and industrial background Mr. Copeland, like other American authors, occasionally appears to over-simplify both industrial and social problems; nevertheless, his book presents a forceful and stimulating analysis of executive requirements necessary for the improvement of industrial efficiency and emphasises their importance. B.E.S.

658 INDUSTRIAL ORGANISATION AND MANAGEMENT

" Small Plant Management : A Guide to Practical, Know-How Management," edited by Edward H. Hempel. A Small Plant Committee Research Study prepared under the auspices of the Management Division of the American Society of Mechanical Engineers. *New York, McGraw-Hill,* 1950. 548 *pages, illus., diags.* £2 15s. 6d.

It must be borne in mind that this is an American publication and therefore deals with problems in America. It certainly contains a very broad account of the progress made by American engineers during the past 100 years or more and this, of course, makes interesting reading. It does appear, however, to have left out the question of human relationship which one would have thought would have a distinct bearing on the management of small plant. H.A.C.

621.97 PRESS WORK

" Pressworking of Metals " by Chauncey Weed Hinman. *Second ed. New York, McGraw-Hill,* 1950. 551 *pages, illus., diags.* £3 12s. 6d.

In this second edition of a very popular and informative book on presswork and its problems, the author has taken full advantage of the extensive progress that has been made in the working of metals, as the result of the last World War. It is admirably suited to both the student and the master of his craft, taking the reader all the way from the very fundamentals of material forming, including the selection of presses for any particular operation, through to the more complicated follow-on and combination tools.

One fine feature is the extent to which drawings and halftone illustrations have been used and the clarity with which they have been lined up with the text.

A chapter has been devoted to a study of the most commonly used materials, including the non-metallic types and this is particularly useful to the designer, and to the foreman tackling new materials for the first time.

One could go on enumerating the good points to be found in this book but it is sufficient to say, that it is one that should have a place on the bookshelf of every Production Engineer who has anything to do with metal forming. H.J.B.

628.9 ILLUMINATION

"Lighting in Industry," *British Electrical Development Association, London. London, the Association,* 1952. 154 *pages, illus., diags.* 9/-. (*Electricity and Productivity Series No.* 2.)

This book is one of a series of eight entitled "Electricity and Productivity." It is an excellent book not only for those who are intimately concerned with problems of illumination, but also for those managers who would value a rapid and easy appreciation of the subject. There is little in the book that can be called new, but it is a well-arranged, comprehensive collection of material covering all aspects.

Some of the questions which confront works managers and executives in industry are:—To what extent does lighting affect individual output?—What is the difference between good and bad lighting?—How can existing lighting be improved and yet be economical in operation?—On what data should lighting systems be planned? This book provides the answers to these questions and many others relating to lighting in industry, as well as providing the necessary data for lighting design.

The book consists of 154 pages, demy octavo, with 85 illustrations, and there are seven chapters entitled respectively:—Lighting and Productivity; Lighting and Factory Managements; Some Particular Factory Lighting Applications; Lighting in Various Industries; Use and Maintenance of Factory Lighting; Colour in Factories, and Lighting Design.

A useful contribution to Chapter II is a detailed account of the method of conducting a lighting survey, which enables factory managements or executives to survey their own factories to see whether the lighting is effective, and used efficiently, to ensure the ideal of "enough light in the right places at all times."

The illustrations clearly demonstrate points raised in the text and the common tendency to illustrate problems that are capable of fairly easy solution has generally been avoided.

The appendices include relevant extracts from the Factories Act, methods of assessing the illumination required for particular situations, and the I.E.S. schedule of recommended illumination values for industrial interiors. L.J.S.

ABSTRACTS

621.791 WELDING : CUTTING

"Joining of Metals." *Institution of Metallurgists, London. Lectures delivered at the Institution's Refresher Course,* 1951. *London, the Institution,* 1952. 174 *pages, illus., diags.* 14/-.

This book appears to be more useful to a metallurgist rather than a student, because it assumes a fairly intimate knowledge of the subject. It is a text-book rather than a work of reference.

The first paper by Dr. Hugh O'Neill is an "interest" lecture. Beginning with a history of welding, it goes on to describe in some detail the physical and chemical action producing a weld. He discusses faults and concludes with a few words about electro-deposition.

The second paper, by W. K. B. Marshall, is concerned with the welding of non-ferrous metals. This is a very large field, so Mr. Marshall confines his remarks mainly to aluminium, copper and nickel, although some generalisation was possible. He discusses the influence of the physical properties of the materials being welded. Cracking and corrosion are also dealt with.

"The Metallurgy of Welding Carbon and Low Alloy Steels" is the subject of the next paper by Dr. Reeve. As the title implies, this is a theoretical paper which covers the chemical aspect in considerable detail.

In Mr. Keating's paper on "Welding of Chromium Nickel Austenitic Steels," his main theme is the "response to welding" of this class of material. He discusses an analytical approach to this problem and the development of these steels for better weldability.

"Soldering and Brazing," by Dr. Chaston, is a paper with a more practical than theoretical approach. It lists cases to which the processes can be applied and gives strength values of the joints produced.

The last paper is called "The Determination of Weldability" by J. S. Ball. Tests are described which can be used by investigators to determine the suitability of materials for welding.

331.1 PERSONNEL MANAGEMENT : EMPLOYER-EMPLOYEE RELATIONS

"Human Relations in Industry"—*Ministry of Labour and National Service, Great Britain. H.M.S.O., London,* 1952. 128 *pages.* 3s. 6d.

This Report is the outcome of a three-day Conference which was held during May, 1952, at the Institution of Civil Engineers. The Conference was called by the Ministry of Labour and National Service for the purpose of assessing:—

(1) the results of action taken concerning human relations in industry during the past few years, and

(2) to consider what is still required to be done and the further steps that would need to be taken.

The agenda for the Conference comprised four subjects:

(a) Factors affecting the Opportunity to Work.
(b) Factors affecting the Capacity of Workers.
(c) Factors affecting Wastage of Manpower.
(d) Factors affecting the Will to Work.

Each of the four study groups was under the Chairmanship of senior officers of the Ministry, and the Report contains the introductory speeches, the statements of the nominated rapporteurs and the resultant discussions which took place on the third day. Included in the Report as appendices are the advance papers which were issued by the Ministry to assist the group discussions, a summary of the findings of the Anglo-American Productivity Teams on human relations in America and a further paper which embodies some of the conclusions from the projects sponsored by the Schuster Panel.

620.19 DEFECTS AND DETERIORATION IN MATERIALS : CORROSION

"Steel Defects and Their Detection" by Henry Thompson. *Pitman, London,* 1952. 84 *pages. Illus.* 15/-.

The object of this book is to combine, in one small compass, a vast miscellany of facts on this one important subject which are scattered throughout the technical literature on this subject.

Basically the book may be divided into three sections. The first lists the defects which may be met with and explains how they are formed. The second gives an account of how macro- and microscopic examinations may be carried out as well as the information which may be deduced from their different features. Lastly, there is a section dealing with special tests, mainly of the non-destructive kind.

340. LAW

"Legal Problems of Employment". *Industrial Welfare Society, London. London, the Society,* 1951. 84 *pages,* 7/6d.

This volume is composed of 204 questions concerning the more common difficulties. These questions are taken from particular industrial cases and the answers are given according to "Law". The questions are grouped together in sections dealing with Terms of Service, Truck Acts, Factory Acts, Liability for Accidents and Welfare Schemes.

620.1791—NON-DESTRUCTIVE TESTING

"**The Non-destructive Testing of Metals**" by R. F. Hanstock. *London, Inst. of Metals,* 1951. 163 *pages, illus. diags.* 21/-. (Institute of Metals—Monograph and Report Series No. 10.)

This book gives a restatement of certain sections of the sciences, mainly classical physics, having a particular bearing on the non-destructive examination of metals. Thus, the theoretical possibilities of radiography, magnetic and ultrasonic methods, damping capacity, X-ray diffraction and numerous other methods are examined and the practical applications of each illustrated by typical examples. The two methods of electron microscopy and electron diffraction have, however, been deliberately omitted, the first because ample alternative literature is available and the second because of its limited application.

679.5 PLASTICS

"**Plastics Molding**" by John Delmonte. *New York, Wiley: London, Chapman & Hall,* 1952. 493 *pages, illus. diags.* £3. 12s. 0d.

Approaching the subject from an engineering viewpoint, this book presents an analysis of the plastic mouldings industry and its many supporting activities, and offers much valuable design data.

The opening chapters on plastic moulding materials give characteristics, flow properties, flow testing methods and detail requirements of standard compounds for various methods of moulding including the cold process, followed by a classification and description of types of hydraulic pumps and applicable mathematical data. Mechanical pressure systems and their applications are described, also hydraulic accumulators and packings. There is information relating to valves and their installation, and also distribution of gases and fluids with charts and information to determine pressure losses.

The various methods of heating plastics, and the application of the methods is covered and also means of estimating heat losses from hot surfaces.

The chapters on Material Preparatory Equipment explain the technique of pre-heating, pre-forming and the requisite equipment. There are chapters on the various methods of moulding, compression, transfer, injection, types of moulds and presses, moulding pressures, methods of loading moulds.

The portion devoted to injection moulding and moulding machines, describes many types and the design features of the moulds. Then follow pages dealing with extrusion equipment and machines, with chapters on finishing and cleaning accessories and methods — instrumentation of the plant, and plant lay-out.

There are numerous illustrations, both photographs and line drawing reproductions, and much data and formulae.

LIBRARY ADDITIONS

010 BIBLIOGRAPHIES; CATALOGUES

Industrial Diamond Information Bureau, London. **List of Books and Pamphlets . . . in Special Library of Industrial Diamond Information Bureau.** *London, Industrial Distributors (Sales) Ltd.,* 1952. 215 *pages.*

338.9 PRODUCTIVITY

English F.G.S. "**The Measure of Progress : A Paper on Productivity.**" *London,* 1953. 18 *pages. Charts.*

519.28 OPERATIONAL ANALYSIS

Batchelor, James H. "**Operations Research : A Preliminary Annotated Bibliography.**" *Cleveland, Case Institute of Technology,* 1952. 95 *pages.* 10/-.

531.7 METROLOGY

Foster, W. H. "**Precision Measurement.**" *2nd ed. Coventry, Coventry Gauge & Tool Co. Ltd.,* [1952]. 50 *pages. Illustrated.*

607 RESEARCH

Great Britain — *Mechanical Engineering Research Board.* "**Mechanical Engineering Research 1951**" *London, H.M.S.O.,* 1952. 37 *pages. Illustrated.* 2/-

621.3 ELECTRICAL ENGINEERING

British Productivity Council, London. "**Electricity and Productivity : A Review of Action taken on the Report of the Electricity Supply Productivity Teams.**" *London, the Council,* 1952. 18 *pages typescript.* (Follow-up statement No. 6.)

621.31561 INSULATING MATERIALS

National Physical Laboratory, Teddington, Middx. "**Properties of Electrical Insulating Materials and Methods of Test.**" *London, H.M.S.O.,* 1952. 16 *pages. Illustrated. Diagrams.* 1/3d. (Notes on Applied Science No. 3.)

621.43 INTERNAL COMBUSTION ENGINES

British Productivity Council, London. "**Streamlining Production : Productivity in the Internal Combustion Engine Industry.**" *London, the Council,* 1952. 15 *pages typescript.* (Follow-up statement No. 5.)

Elton, Arthur. "**The Engine**". *London, Shell Petroleum Co.,* [1953]. 38 *pages. Illustrated. Diagrams.* (Motoring Books.)

621.73 FORGING

British Productivity Council, London. "**Utilising the Hammer : Productivity in the British Drop-forging Industry.**" *London, the Council,* 1952. 13 *pages typescript.*

621.74 FOUNDRY WORK

British Productivity Council, London. "**Servicing the Moulder : A Review of Productivity in the Grey Ironfounding Industry.**" *London, the Council,* 1952. 18 *pages typescript.*

British Productivity Council, London, "**Something Has Been Done : Productivity in the British Steelfoundng Industry.**" *London, the Council,* 1952. 8 *pages typescript.*

Monsanto Chemical Company, Springfield, Mass. "**Shell Molding Process : A new and Proved Casting Method for the Founding Industry.**" *Springfield, the Company,* 1952. 28 *pages. Illustrated. Diagrams.*

621.771 ROLLING MILLS

Shell-Mex and B.P. Ltd., London. "**Oil and Steel : A Record of the Lubrication by Shell Oils and Greases of the New Plant at the Abbey Works of the Steel Company of Wales Ltd.**" *London, the Company,* 1952. 36 *pages. Illustrated. Chart.*

621.775 POWDER METALLURGY

New Jersey Zinc Company, New York. "**Facts—About Pressed Brass and Other Non-ferrous Powder Parts.**" *New York, the Company,* 1952. 32 *pages. Illustrated.*

621.83 GEARS

British Insulated Callender's Cables Ltd., London. "**Paper Pinion and Spur Gears.**" *London, the Firm,* 1952. 24 *pages. Illustrated. Diagrams.*

Vacuum Oil Company Ltd., London. "**Gear Lubrication.**" *London, the Company,* 1953. 57 *pages. Diagrams.* (Vacuum technical series No. 6.)

621.86 MATERIALS HANDLING

Hyter Company, Portland, Oregon. "**How to Operate a Lift Truck.**" *Portland, the Company,* 1952. 23 *pages. Illustrated.*

621.88 MEANS OF ATTACHMENT; SEALING

Partridge, J. H. "**Glass-to-metal Seals.**" *Sheffield, Society of Glass Technology,* 1949. 238 *pages. Illustrated. Diagrams.* £1. 15s. 0d. (Monographs on Glass Technology.)

621.882 SCREWS; SCREW THREADS

Cormac, P. "**Treatise on Screws and Worm Gear, their Mills and Hobs.**" *London, Chapman & Hall,* 1936. 138 *pages. Diagrams.*

621.89 LUBRICATION; CUTTING FLUIDS

Esso Petroleum Company Ltd., London. **"Cutting Fluids."** *London, the Company,* 1952. 48 *pages. Illustrated. Diagrams.* 7/6d.

Regent Oil Company Ltd., London. **"Caltex Cutting Oils and Coolants."** *London, the Company,* [195-]. 50 *pages. Illustrated.*

621.9 MACHINE TOOLS; MACHINING

British Productivity Team on Metalworking Machine Tools. **"Metal Working Machine Tools : Report of a . . . Team . . . which visited the U.S.A. in 1951."** *London, British Productivity Council,* 1953. 88 *pages. Illustrated. Diagrams.* 3/6d. (Productivity Team Report.)

French, James Weir. **"Machine Tools."** *London, Gresham Publishing Co.,* 1911. 2 *vols. Illustrated sectional models.*

Merchant, M. Eugene, and Ernst, Hans. **"Principles of Metal Cutting and Machinability . . . reprinted ... from A.S.T.E. Tool Engineers Handbook."** *Cincinnati, Cincinnati Milling Machine Co.,* [195-]. pp. 302 - 356. *Diagrams. Charts.*

621.9091 TOOLS

"Diamond Tool Industry in 1952." *London, Industrial Diamond Information Bureau,* 1953. 8 *pages.*

Institution of Production Engineers, London—London Graduate Section—Technique of Tooling Study Group. **"Comparative Operating Times of Tool Elements : Interim Report."** 1953. 6 *pages typescript. Photographs.*

Wickman Ltd., Coventry. **"Applying Wimet Tungsten Carbide Tools."** *Coventry, the Firm,* [*n.d.*]. 32 *pages. Illustrated. Diagrams.*

Wickman Ltd., Coventry. **"Reservicing Wimet Tungsten Carbide Tools."** *Coventry, the Firm,* [*n.d.*]. 32 *pages. Illustrated. Diagrams.*

621.92 GRINDING; POLISHING

Carborundum Company Ltd., Manchester. **"Cutting off with Abrasive Wheels."** *Manchester, the Company,* 1952. 16 *pages. Illustrated.*

Carborundum Company Ltd., Manchester. **"Grinding Wheel Gradings, incorporating Common Errors in Precision Grinding."** *Manchester, the Company,* 1952. 95 *pages. Diagrams.*

Carborundum Company Ltd., Manchester. **"Truing and Dressing of Grinding Wheels."** 2*nd. ed. Manchester, the Company,* [*n.d.*]. 31 *pages. Illustrated. Diagrams.*

Wickman Ltd., Coventry. **"Optical Profile Grinding Machine."** *Coventry, the Firm,* [*n.d.*]. 36 *pages. Illustrated. Diagrams.*

621.94 AUTOMATICS

Wickman Ltd., Coventry. **"Wickman Sliding Head Precision Automatic, 7/16" : Operator's Handbook."** *Coventry, the Firm,* [195-]. 78 *pages. Illustrated. Diagrams.*

Wickman Ltd., Coventry. **"Operator's Manual . . . five-spindle automatic bar and chucking machines."** *Coventry, the Firm,* 1952. 127 *pages. Illustrated. Diagrams.*

621.97 PRESS WORK

Hinman, Chauncey Weed. **"Die Engineering Layouts and Formulas."** *New York, McGraw-Hill,* 1943. 497 *pages. Illustrated. Diagrams.* £2. 7s. 0d.

621.979 MOULDING MACHINES

British Moulding Machine Company Ltd., Faversham Kent. **"Instructions for the Installation, Operation and Maintenance of Type B.T.I."** *Faversham, the Company,* 1952. 38 *pages. Illustrated. Diagrams.*

622 MINING

Wakefield, C. C., & Co. Ltd., London. **"Colliery Lubrication."** *London, the Company,* 1951. 63 *pages. Illustrated. Diagrams.* (Wakefield technical series.)

624.0142 STEEL STRUCTURES

British Constructional Steelwork Association, London. **"Collapse Method of Design, being the Application of the Plastic Theory to the Design of Mild Steel Reams and Rigid Frames . . . Prepared . . . in collaboration with the British Welding Research Association."** *London, the Association,* 1952. 52 *pages. Diagrams.*

British Constructional Steelwork Association, London. **"Use of Welding in Steel Building Structures."** *London, the Association,* 1952. 35 *pages. Diagrams.*

629.11 MOTOR VEHICLES

Northern Aluminium Company Ltd., London. **"Light Alloy Bodies for Road Haulage Vehicles."** *London, the Company,* 1952-53. 2 *parts. Diagrams. Book* 1, **"Materials and General Practice."** *Book* 2, **"Flat Platform and Drop Side Designs."**

629.13 AIRCRAFT ENGINEERING

Keith-Lucas, D. **"The Shape of Wings to Come."** *London, Newman Neame Ltd.,* 1952. 39 *pages. Illustrated. Diagrams.*

648.23 LAUNDRY MACHINERY

Wakefield, C. C., & Co. Ltd., London. **"Laundry Machinery Lubrication."** *London, the Company,* 1951. 56 *pages. Illustrated. Diagrams.* (Wakefield Technical Series.)

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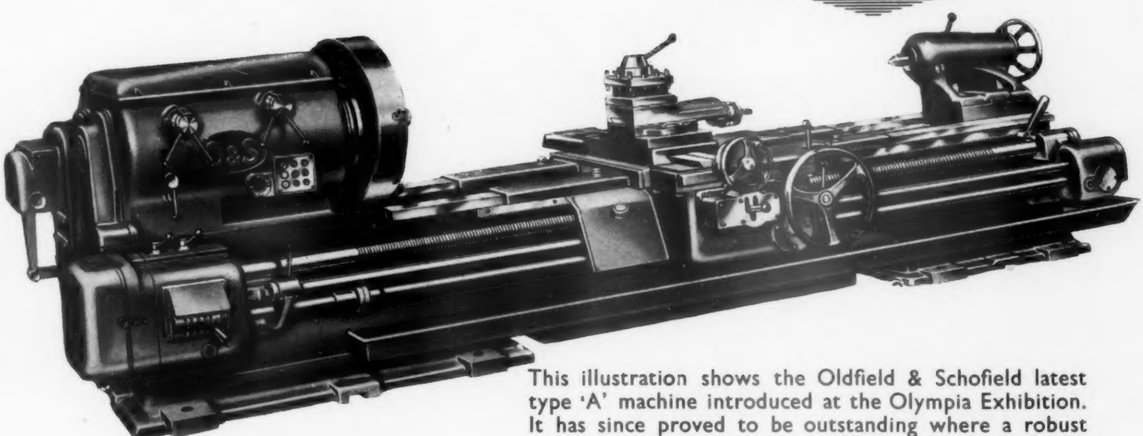

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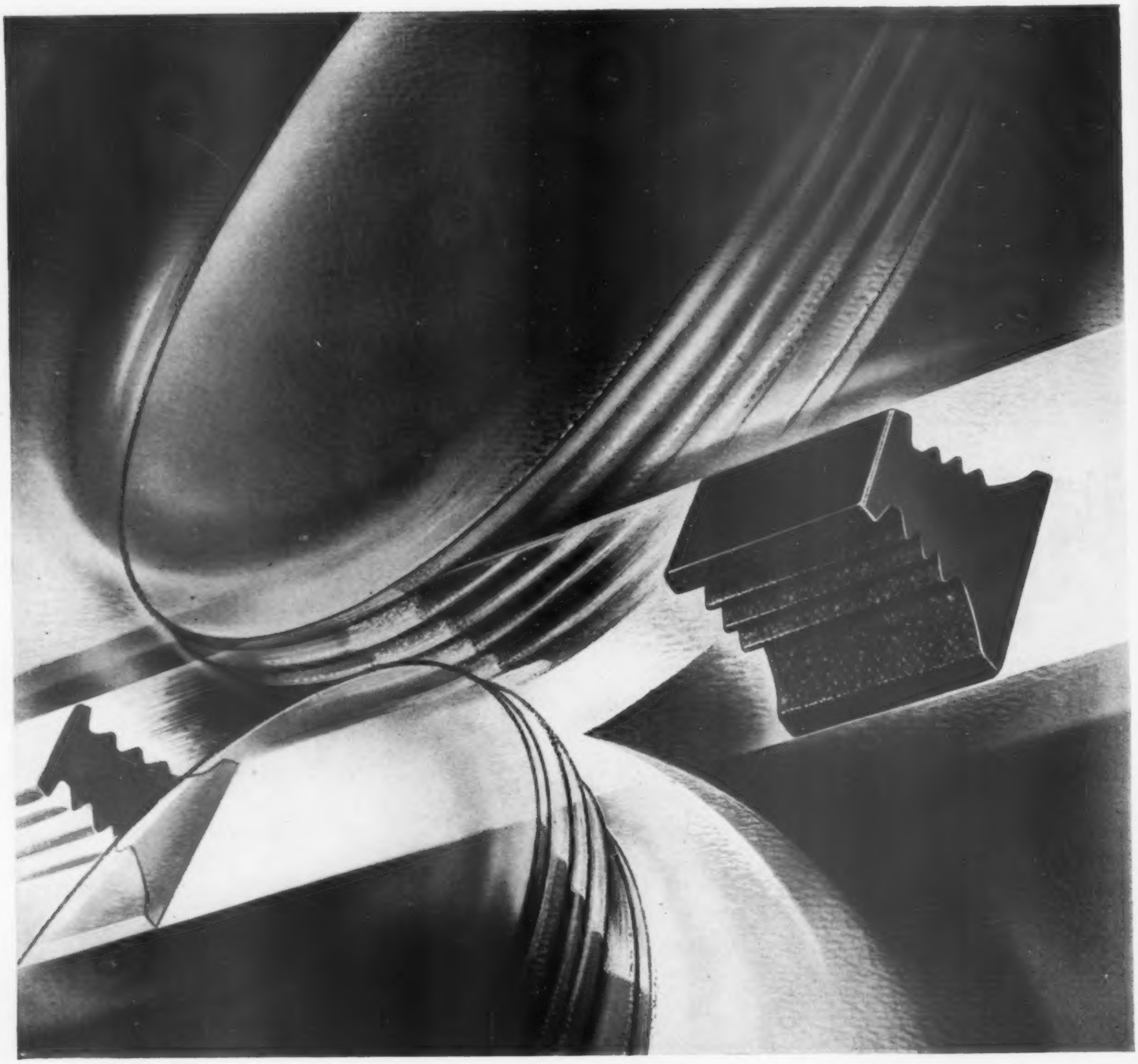

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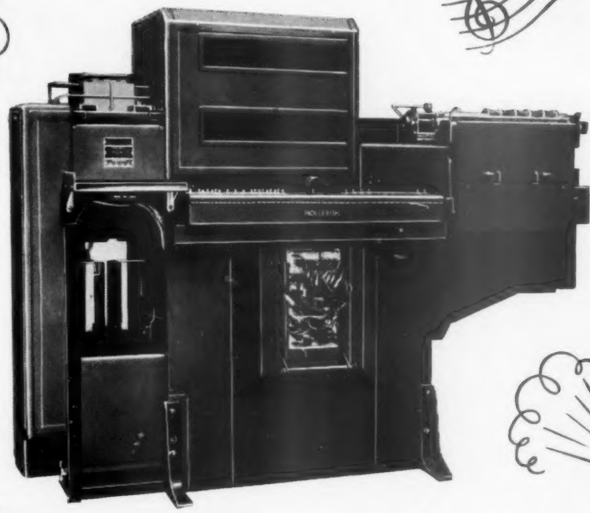


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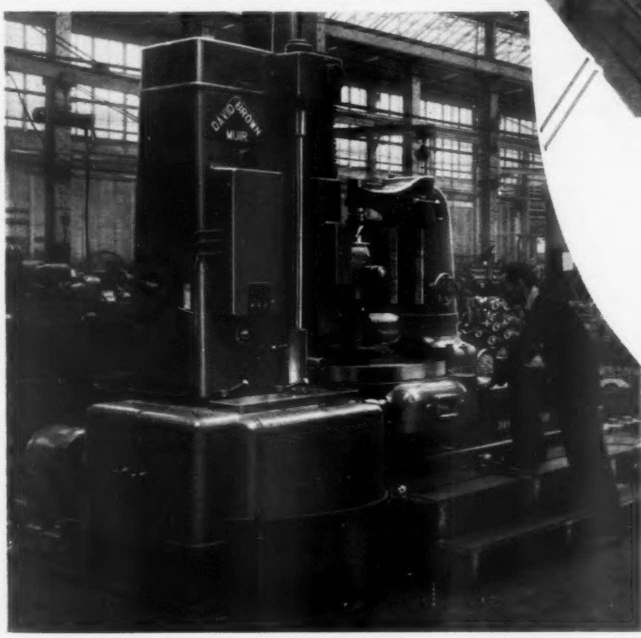

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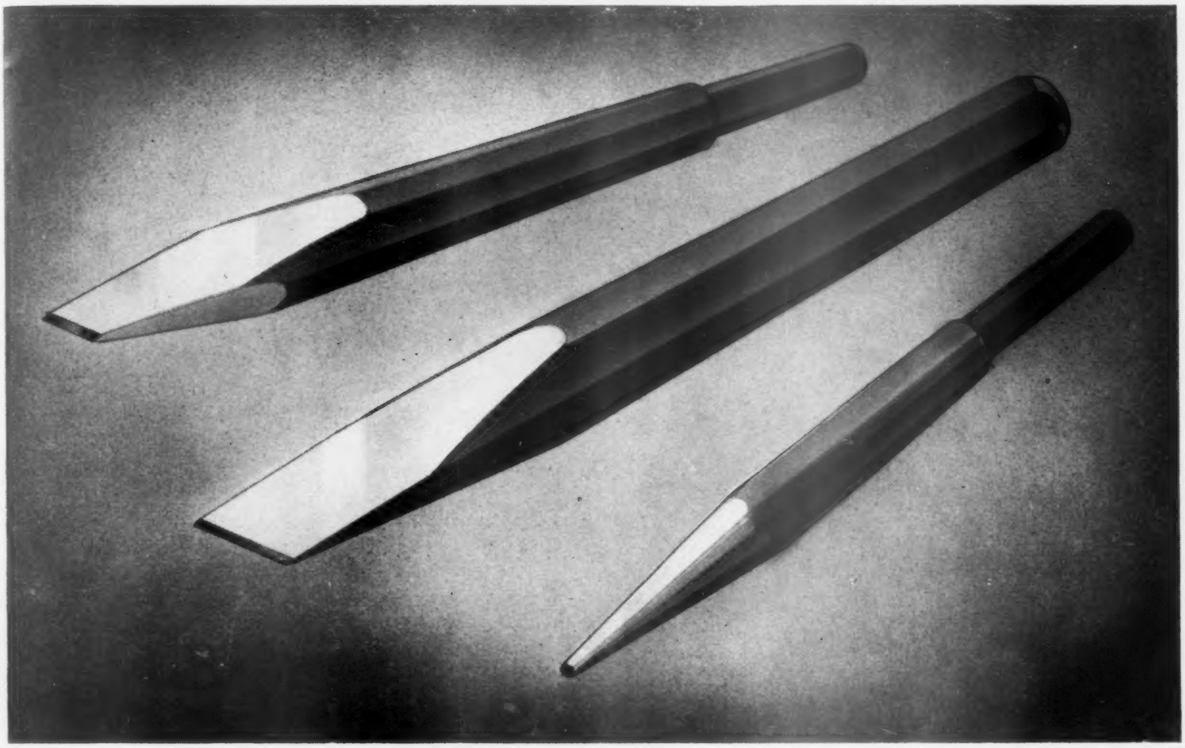

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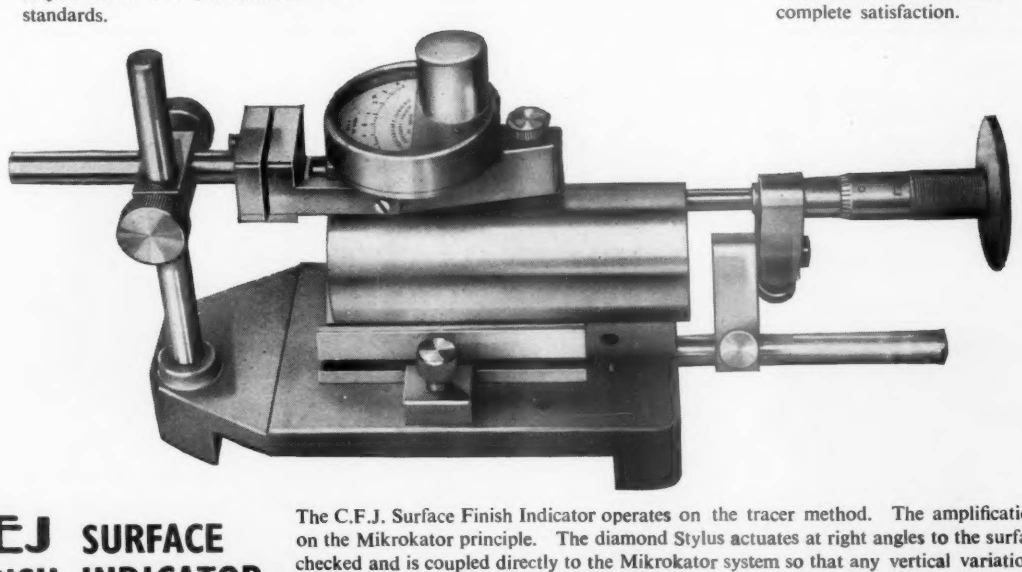

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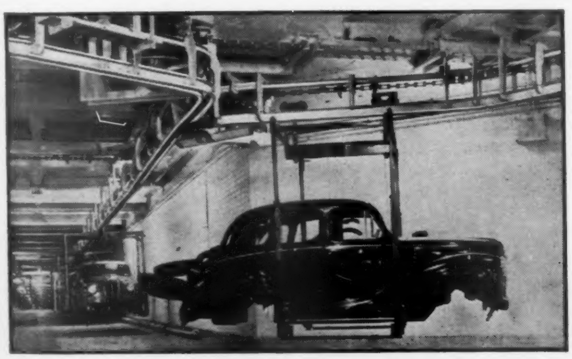

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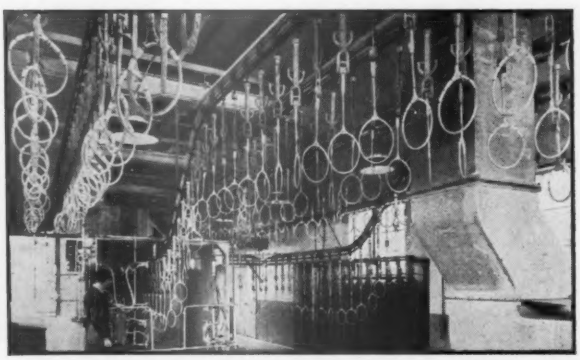

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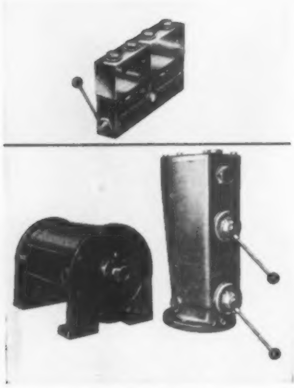

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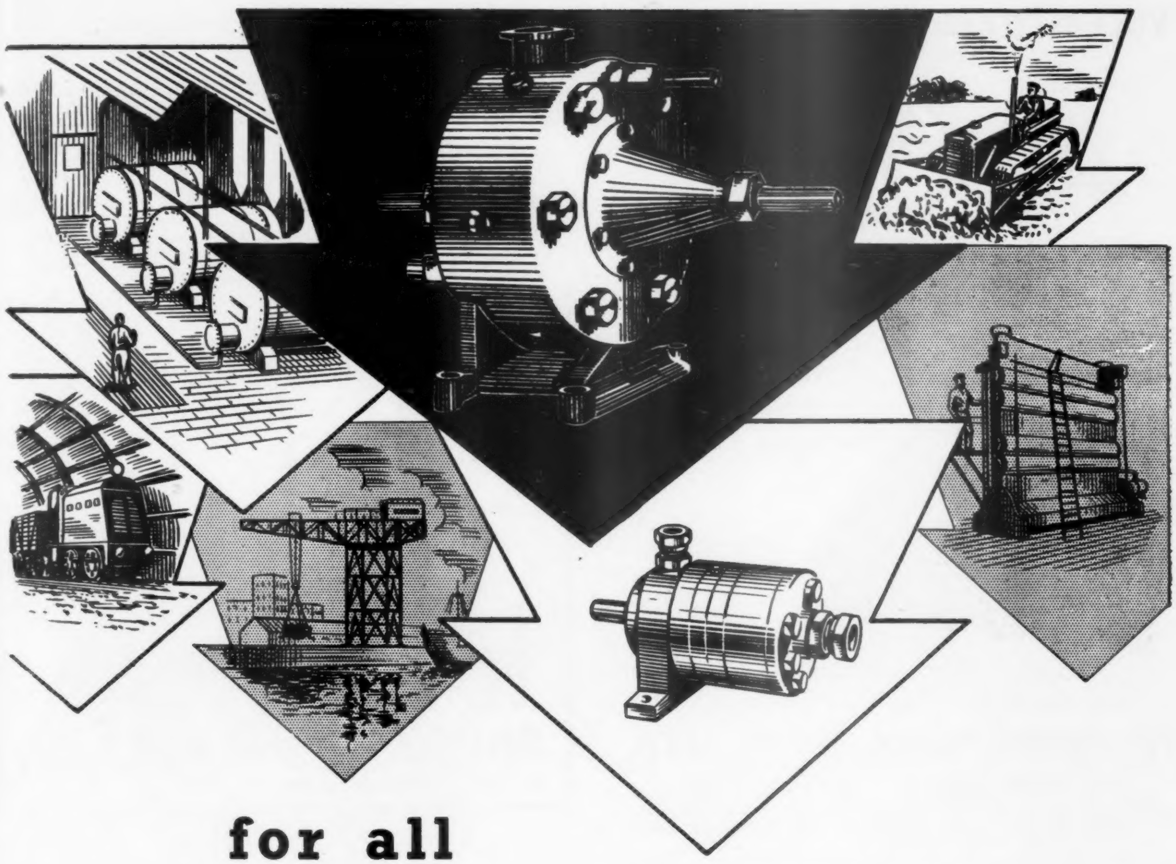

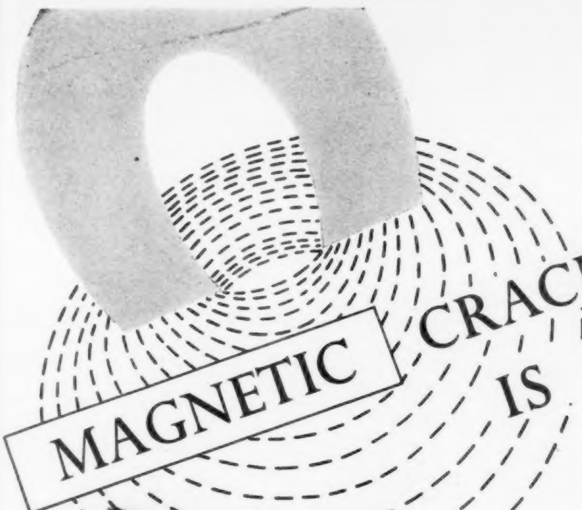

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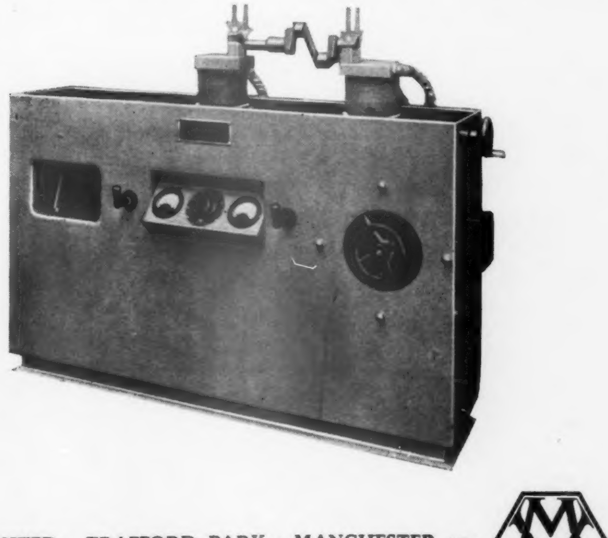
Even when too fine to be detected by any normal inspection method, surface cracks can be discovered immediately with Metrovick magnetic crack detection equipment. Developed primarily for practical tests on components produced in the company's own factories, ranging from large forgings to small pinions, this Metrovick equipment is very simple in operation. Use is made of a special magnetic fluid which, after passage of the magnetising current, enables all cracks to be seen with the naked eye. Most requirements in industry can be met from the standard range of Metrovick crack detectors. Special equipment can, however, be made to order. Please write for full technical details.

No cracks of any sort were visible in this pinion before testing by the Metrovick magnetic method. The whole series of very fine surface cracks shown in the photograph was introduced by heavy grinding after hardening. These emerged clearly when tested with the crack detector. Highly stressed components subjected to grinding, welding, heat treatment, pickling, plating, or similar operations, may be tested as a routine measure with Metrovick equipment.



The Metroflux Type 'S' universal magnetic crack detector is an extremely flexible unit. It is of great value for testing components of large size or awkward shape, and for routine testing of mass-produced components.

METROPOLITAN-VICKERS ELECTRICAL COMPANY LIMITED · TRAFFORD PARK · MANCHESTER 17

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METROVICK *Magnetic Crack Detectors*

INDEX TO ADVERTISEMENTS

	Page
Accles & Pollock, Ltd.	lxiv
Accles & Shelvoke, Ltd.	lxx
Adam Machine Tool Co., Ltd. ...	xlvi
Allen, Edgar & Co., Ltd. ...	xlix
Andrews, Harold, Grinding Co., Ltd.	—
Asquith, William, Ltd.	xxii
Automatic Coil Winder & Electrical Equipment Co., Ltd. ...	—
Barber and Colman, Ltd. ...	—
Baty, J. E., & Co., Ltd.	—
Birlec, Ltd.	—
Birmingham Aluminium Casting (1903) Co., Ltd.	—
Block and Anderson, Ltd. ...	—
Bratby and Hinchcliffe, Ltd. ...	lvi
Bray, George, & Co., Ltd. ...	—
British Aero Components Ltd. ...	—
British Die Casting and Engineering Co., Ltd.	lxi
British Electrical Development Association	xlii
B.H. Chemicals, Ltd.	—
British Industrial Plastics, Ltd. ...	xiii
British Tabulating Machine Co., Ltd.	xxxv
British Thomson-Houston Co., Ltd.	—
Brooks and Walker, Ltd. ...	lxviii
Broom and Wade, Ltd.	xxxviii
Brown, David, Machine Tools, Ltd.	xlvii
Catmur Machine Tool Corporation, Ltd.	lv
Churchill, Charles & Co, Ltd. ...	—
Churchill Machine Tool Co., Ltd.	—
Cincinnati Milling Machines, Ltd.	iii
Climax Rock Drill & Eng. Works Ltd.	—
Cossor, A. C., Ltd.	xl
Coventry Gauge and Tool Co., Ltd.	xvii
Dawson Bros., Ltd.	lx
Dean Smith and Grace, Ltd. ...	xlv
Designex (Coventry), Ltd. ...	lxvi
Donovan Electrical Co., Ltd. ...	—
Drummond-Asquith (Sales), Ltd.	xxiii
Drummond Bros., Ltd.	xiv
Dyson and Co. Enfield (1919), Ltd.	vi
E.M.B. Co., Ltd.	lx
English Electric Co., Ltd. ...	—
English Steel Corporation, Ltd.	lvii
Firth Brown Tools, Ltd. ...	—
Firth, Thos., & Brown, John, Ltd.	—
Fisher and Ludlow, Ltd. ...	—
Flame Hardeners, Ltd.	—
Fox, Samuel & Co., Ltd. ...	—
Fraser, Andrew, & Co., Ltd. ...	lxvii
Gledhill-Brook Time Recorders, Ltd.	xlviii
G.P.A. Tools and Gauges, Ltd. ...	xxxvi
Guest, Keen & Nettlefolds (Midlands), Ltd.	—
Guylee, Frank, and Son, Ltd. ...	l
G.W.B. Electric Furnaces, Ltd ...	—
Hampton, C. and J., Ltd. ...	—
Harrison, T. S., and Sons, Ltd.	xvi
Harris Tools, Ltd., John ...	—
Herbert, Alfred, Ltd.	xxix
Hilger and Watts, Ltd.	—
Holbrook Machine Tool Co., Ltd.	—
Holman Bros., Ltd.	*Outside Back Cover*
Hoover, Ltd.	xxxi
Horden, Mason and Edwards, Ltd.	xxxvii
Imperial Smelting Corporation (Sales), Ltd.	xix
Impregnated Diamond Products, Ltd.	li
Johansson, C. E., Ltd.	liii
Jones, E. H. (Machine Tools), Ltd.	xliii
Jones, Sidney G., Ltd.	xv
King, Geo. W., Ltd.	lix
Lancashire Dynamo and Crypto, Ltd.	—
Lancing Machine Tools, Ltd. ...	ix
Lang, John, and Sons, Ltd. ...	—
Lang Pneumatic Ltd.	—
Lapointe Machine Tool Co., Ltd.	xii
Lloyd, Richard, Ltd.	xii
Lund, John, Ltd.	xi
Machine Shop Equipment, Ltd.	viii
Machinery Publishing Co., Ltd.	lxvi
Magnesium Elektron, Ltd. ...	xxvii
Marbaix Gaston E., Ltd. ...	xx, xxi
Marshall-Richards Machine Co., Ltd.	—
McGraw-Hill Publishing Co., Ltd.	xxxix
McKechnie Bros., Ltd.	lxii
Melbourne Engineering Co., Ltd.	lii
Metropolitan-Vickers Electrical Co., Ltd.	lxix
Midland Saw & Tool Co., Ltd.	lxvi
Mollart Engineering Co., Ltd. ...	lvi
Monks and Crane, Ltd. ...	vii
Myford Engineering Co., Ltd. ...	lxiv
Neill, James, and Co. (Sheffield), Ltd.	—
Newall, A. P., and Co., Ltd. ...	lii
Newall Group Sales, Ltd. ...	xxx
Park Gate Iron and Steel Co., Ltd.	*Inside Back Cover*
Parkinson, J., and Son (Shipley), Ltd.	xxiv
Paterson Hughes Engineering Co., Ltd.	xxxii
Power-Samas Accounting Machines (Sales) Ltd.	xxxiii
Press Equipment Co.	—
Projectile and Engineering Co., Ltd.	liv
Pryor, Edward, and Son, Ltd. ...	l
Radio Heaters, Ltd.	lxiv
Raglan Engineering Co. (Nottingham), Ltd.	lviii
Ransomes, Sims, and Jefferies, Ltd.	lxii
Reavell and Co., Ltd.	liv
Redfern's Rubber Works, Ltd. ...	xlvi
Reliance Gear & Eng. Co. (Salford), Ltd.	lxvi
Riley, Robert, Ltd.	—
Russell, S., and Sons, Ltd. ...	xlviii
Scrivener, Arthur, Ltd.	—
Selson Machine Tool Co., Ltd.	lxv
Shell Mex and B.P. Ltd. ...	v
Skinners (Redbridge), Ltd. ...	—
Sparklets, Ltd.	—
Spencer & Halstead, Ltd. ...	—
Sunbeam Anti-Corrosives, Ltd.	—
Swift, Geo., and Son, Ltd. ...	—
Sykes, W. E., Ltd.	xxxiv
Tecalemit, Ltd.	xxviii
Teleflex Products, Ltd.	—
T.I. Aluminium, Ltd.	xli
Turner Machine Tools Ltd. ...	lxviii
Unbrako Socket Screw Co., Ltd.	iv
United Steel Companies, Ltd ...	—
Van Moppes and Sons (Diamond Tools), Ltd.	xxvi
Vulcascot (Great Britain), Ltd. ...	lxviii
Ward, H. W., and Co., Ltd. ...	xxv
Ward, Thos. W., Ltd.	xliv
Wickman, Ltd.	x, xviii
Wild Barfield Electric Furnaces, Ltd.	—
Winn, Chas., and Co., Ltd. ...	lviii
Wolverhampton Die Casting Co., Ltd.	lxiii
Zinc Alloy Die Casters Association	—

urnal

push
y and

djust-
rtical

CE

56 6

Page

—
Lii
xxx

Cover
xxiv
xxii
xxiii

Liv
L
Lxiv
Lviii
Lxii
Liv
xLvi
Lxvi
—
Lviii
—
Lxv
v
—
—
—
—
xxiv
xviii
—
xLi
xviii
iv
—
xxvi
xviii
xxv
xLiv
xviii
—
Lviii
Lxiii
—